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THROUGH THE EYES OF THE EDITOR

Ralph H. Boos discusses various factors involved in complete denture service and describes a complete technique for making dentures. He shows the relationship of his technical procedures with certain anatomic and physiologic principles. He emphasizes the importance of preparing the patient properly before the technical procedures are started. This has a comparable influence on the end result in the same manner as do the preparations insisted upon by surgeons. It is too often neglected by dentists. He uses a nondisplacement impression procedure. This should serve a large percentage of patients very well. However, when certain portions of the underlying bone are sharp, some modification may be indicated. A comparison of biting forces possible with bases made with different techniques may be open to question, on account of the relative experience of various operators with different techniques. He suggests that some dentures should be built with the mandible at some other position than centric position. There is danger in this approach. If the dentures are built to occlude properly in centric relation, and *if the occlusion is balanced properly in all other relations within the functional size of the teeth,* there can be no problem of malocclusion for *any* closure. The establishment of the occlusal vertical dimension with an arbitrary closure of 3 mm. from rest position is not always satisfactory. The modifications he suggests are worth consideration. The procedure he suggests might be improved by eliminating some of the changes occurring in processing the dentures, by remounting the new dentures according to new interocclusal records made at the time the dentures are inserted.

Thomas E. J. Shanahan discusses a physiologic approach to the problems of recording vertical dimension and centric relation. He compares different methods for making these records, and suggests techniques for using physiologic activities as the means for placing the mandible in the proper position for each of the records. The techniques are not difficult, but they require an understanding of the principles involved and skill in the control of the patient if errors are to be avoided.

H. A. Young discusses the many factors involved in esthetics of dentures. He groups the factors in such a way that they can be considered in relation to each other as well as to the end result. He concludes that the dentist must be an artist and must not expect esthetics to be pleasing automatically. It takes study, care, an artistic sense, and a willingness to apply esthetic principles if the dentist is to produce dentures that defy detection.

Arthur S. Freese suggests the use of the rubber base impression materials for lining hard baseplates, and describes a technique for building occlusion rims with these materials. The advantages of occlusion rims made in this manner are obvious.

Raymond Cohen reports his experiments to determine the relationship of the anterior

guidance in mandibular movement. He used the McCollum Gnathoscope to make the records from a patient and the Gnathograph to analyze the records. The results indicate the desirability of making records of the condylar paths, and that the condylar paths are not changed by variations of the incisal guidance. The conclusion that "there is only one tooth form" for any one individual is not necessarily true. If the compensating curve or the inclination of the occlusal curvature can be varied, the tooth form can be modified correspondingly to develop a satisfactory occlusion.

John J. Sharry, Irving J. Weber, and Charles Parkel report their studies of the influence of occlusal planes on the strains in the edentulous maxillae and mandible. Their observations were made of cracks in a lacquer coating on the bones. They conclude that 30 degree inclinations in the occlusal surfaces produce more force on the bones than flat surfaces. However, the increase in strain patterns may indicate only a more diversified direction of these forces. Further study of this nature is needed.

Chester Perry discusses his philosophy of partial denture design. It is quite logical, especially when he suggests that an accurate diagnosis be arrived at and the entire plan of treatment be worked out *before* any technical procedures are started. It is unfortunate that so many people still think in terms of replacing missing teeth. The ultimate oral health of the patient is determined primarily by the way all of the interrelated factors are coordinated. He sets up basic requirements for the restoration as an entity as well as specifications for the component parts of the removable partial denture. Most of these are quite sound, but there may be some question about the suggested use of a broad lingual bar which rests on the lingual surfaces of lower anterior teeth. This type of major connector can interfere with the health of the gingivae and the periodontal tissues if it is not used properly.

Lawrence A. Weinberg analyzes the actions and effects of lateral forces applied to removable partial dentures. He classifies lateral forces according to their components and determines the affect of each upon the design of denture bases, clasps, and connectors. The tests were conducted upon specially designed models which show the affects of each component of force on each unit of the partial denture design. His experiments seem to bear out the recommendations of most leading clinicians. A consideration for the torques he illustrates should result in designs of partial dentures which will reduce the damage to abutment teeth which is found so frequently with dentures designed with retention alone as the objective.

S. Charles Brecker discusses the use of porcelain baked to gold for dental restorations, and describes the materials and techniques involved. These procedures appear to be practical provided each step is carried out properly. He warns that the procedures are exacting and that experience is necessary for the satisfactory use of these materials and techniques.

John F. Johnston, R. W. Dykema, and D. M. Cunningham make a progress report on their tests of porcelain fused to gold in dental restorations. Their laboratory as well as clinical tests seem to indicate the value of these materials and techniques. They discuss the various factors which may influence the effectiveness of the procedures. One of the difficulties which is apparently not yet completely overcome is in the accurate prediction of the color of the porcelain in the completed restorations. Undoubtedly, this problem will be solved after more research such as is reported here.

Charles M. Chayes and Gerald A. Finkelstein discuss the advantages and disadvantages of various techniques for making roentgenograms of the temporomandibular joint. They describe the apparatus and a technique for making this type of roentgenogram and claim that it obviates the disadvantages of other methods. The weak point in this work remains in the interpretation of the roentgenograms. A standardized technique will help solve the problems of interpretation, but much more needs to be done in this field.

Russell C. Wheeler, reporting for the Committee on Scientific Investigation of the American Academy of Restorative Dentistry, reviews the current literature on many topics

of interest to dentists. This report contains much information which should be of value to all dentists, even though some of it is not directly connected with their specialty.

George E. O'Brien and John C. Brutting suggest a modification in the usual dental office organization. There are points of merit in the use of more male help in the dental office provided the right kind of assistance can be found. It seems that to find a man who was trained as a dental laboratory technician, and who could or would do the work normally done by a secretary or female assistant might be difficult. The suggestion is worthy of study by those who have the type of practice that it might fit.

—Carl O. Boucher

PHYSIOLOGIC DENTURE TECHNIQUE

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THE ANATOMIC STRUCTURES INVOLVED in complete denture construction include bone and soft tissues, nerves and blood vessels, the musculature, and the temporomandibular joints. The soft tissues are chiefly those included in the denture area, although the temporomandibular joint, the throat, and the facial structures are also affected. As the tissues in the denture areas are affected, likewise the nerves and blood vessels of the same areas are affected. The musculature involved includes not only that in relation to the borders of the dentures, but also the muscles of mastication and the muscles of the head and neck. The complete masticatory system and esthetics are involved.

The normal physiology and structure of the anatomic areas involved may be affected by malfunction, pathology, allergy, diet, psychology, tissue displacement, and pressure. Malfunction may be due to malocclusions, loss of teeth, and acquired conditions. These conditions are often present previous to dentures, and may be one of the causes attributing to the need for dentures. The musculature and the temporomandibular joint may be affected by the malfunction as well as the masticatory habits. To proceed with the technical steps of denture construction without correcting the abnormal conditions present may extend the malfunction to the dentures and result in their limited use or failure. This corrective treatment involves conditioning the muscles which, in turn, will aid in placing the mandible and the condyle in the temporomandibular joint in a more normal position. Conditioning may be accomplished by an exercise which stretches the muscles and allows them to come back to a rest position (Fig. 1). A complete exercise is to have the patient hold the head in an upright position and go through a series of movements of the mandible. First the patient opens wide for about one-half minute, then relaxes and lets the mandible come to rest position. Do not attempt to position the jaw. The teeth should never come together, so that there will not be any guidance by the existing occlusion. Next, the patient moves the jaw to the right, as far as possible, in a slow continuous stretch and then lets it drop back to rest position. Then he moves the jaw to the left and drops it back; then forward, back to rest, retruded as far as possible, and then to rest, and then open and back to rest. The forward position and dropping back to rest, as well as opening wide and coming to rest, will often help in bringing about a normal unstrained mandibular position. This exercise may be used as a prescription by requiring the patient to follow the prescribed movements for two or three minutes, four times a day. The times that would be convenient are morning after arising,

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around ten o'clock, around three o'clock, and upon retiring. The patient should always be cognizant of maintaining a space between the teeth, and avoiding biting habits. If the dentures interfere, they should be removed during these exercises. Whenever the patient finds himself biting on his teeth, he should open and stretch the muscles to relieve tension. The exercise is in no sense a method to develop muscle power. It is a procedure to relieve tension and learn relaxation. Exercises such as chewing gum should be avoided.

Fig. 1.—The stretch and relax exercises that condition the muscles are: open to rest, left to rest, right to rest, forward to rest, back to rest, and open to rest.

PATHOLOGY

Pathology of oral structures should be carefully noted by clinical observation and roentgenograms. Lesions of leukoplakia, precancerous lesions, or any questionable condition should be supported by biopsy and/or referred for treatment. Roentgenograms will aid greatly in examination for remaining teeth or roots of teeth, and conditions such as cysts or tumors.

ALLERGY

Allergy to denture materials is always a possibility, although, fortunately, the percentage of these cases is extremely low in comparison to the number of

dentures constructed. Many times, affected areas and burning sensations are attributed to an allergy when the actual cause is malfunction, pressure on nerve endings, or systemic conditions. The majority of so-called allergies are due to these other causes. A true allergy may be considered as a possibility when all of the mucous membrane in contact with the denture base material becomes irritated and inflamed. An allergy exists, if, when the denture is removed, the inflamed condition improves, and when the denture is returned to position, the inflamed condition returns. The function of the denture should be near normal to eliminate malfunction as a possible cause. Inferior materials and improper processing may also be the cause of an allergic reaction; and then there are true cases of allergy to certain materials. The treatment is experimentation with other materials, such as changing from the copolymer methacrylate resins to the vinyl resins or to styrene resins. The most inert material would be a metal which is used as a surgical alloy.

The tone and the tolerance limits of tissue may be affected by the diet or systemic condition of the patient. Observation of substandard tissue and osseous structure should be investigated further by a general diet discussion. Often a report on a ten-day intake of food will indicate unusual diet habits. Natural foods, organic vitamins, and/or the therapeutic dosage of B and C vitamins are an aid in some cases. Extreme cases may be referred to a physician or nutritionist.

PSYCHOLOGY

Psychology is perhaps one of the most important factors affecting the results in denture construction. The variation may be from that of the cooperative, tolerant patient to the opposite, who treats the denture as a foreign object and will not adjust to the limitations of a prosthetic service. A few planned questions regarding his dental history, and the patient's viewpoint on prosthetics will provide leads concerning the involvement of psychosomatics. Observation of biting and nervous habits aid in predetermining the excessive use and bearing which will be placed on the dentures. The relaxation exercise previously suggested is recommended to relieve and treat biting habits, as well as psychologic conditions. The exercise treatment helps the patient recognize his own habits and gives him something definite to do in treatment.

TISSUE DISPLACEMENT AND PRESSURE

Tissue displacement and pressure are present, in varying degrees, in every denture patient after the first denture is constructed and worn for a period of time. The supporting area of the denture base is on tissue which is movable and displaceable. The amount of change which takes place is dependent on the individual tolerance and habits of the patient which may or may not cause abnormal pressure. Many times the history of a denture patient includes a succession of dentures constructed on displaced tissue. As each denture or reline is constructed, the old denture is removed and an impression is made of the tissues in their displaced condition. Under certain conditions, this may result in extreme displacement with varying degrees of recession plus possible nerve pressure expressed by sensitive

areas and a burning sensation. Observation of some patients will show the rugae and the incisive papilla greatly displaced. The incisive papilla is a protection to the incisive foramen through which nerves and blood vessels pass. These factors may be treated by conditioning the tissue and by a nondisplacement procedure in the denture construction.

CONDITIONING

Every patient requires the conditioning of supporting tissue and musculature, even if all conditions appear normal. At the time the denture service is contracted, the patient should be put on the relaxation exercises. This will provide at least a week to ten days of conditioning before jaw relations are registered. The longer the time, the greater the advantage in obtaining and facilitating a normal registration.

For tissue conditioning, the patient should refrain from wearing the old denture for an absolute minimum of twelve to fourteen hours before the final impression for the new denture or reline is obtained. Every patient is able to be without dentures and on a soft diet at least overnight. In cases of malfunction, inflamed areas, or burning sensations, the time should be extended from twenty-four to forty-eight hours, many days, or even weeks. The patient should be instructed to cleanse and stimulate the tissue by washing with cotton balls or a soft toothbrush, using a normal saline solution or a mouthwash. An exercise to increase the blood circulation of the oral cavity is taking a deep breath and closing the throat to stop exhaling while forcing the diaphragm down. This will raise the blood column and increase relief and circulation in the denture areas. During the conditioning period this may be done a few times and then done again just previous to making the impression.

PRINCIPLES

The technical procedure of a physiologic denture technique is based on several principles which aid in maintaining normal conditions. A nondisplacement type of impression is obtained because of the advantage provided. The tissue tolerance to biting force of different impression techniques was compared by processing denture bases on casts obtained from different impression techniques and then using a gnathodynamometer to register maximum biting force. The same patient had bases constructed on casts made from (1) a displacement impression, (2) a modified displacement impression, and (3) a nondisplacement impression. Each set of bases made from casts of different impression techniques was tested for maximum biting force. The results indicated approximately 20 per cent more tolerance to biting force with the nondisplacement technique bases over the displacement technique bases and 10 per cent over the modified displacement bases. These percentages could be varied by operator manipulation, but the nondisplacement technique indicated a definite advantage.

JAW RELATIONS

Physiologic rest position is used as a diagnostic reference position to establish vertical dimension including free-way space, centric relation, and a bilateral balance of jaw relations.

Rest position and maximum biting force[1] are at the same position in vertical dimension (Figs. 2 and 3). This provides a position of reference for establishing efficiency in mastication. In ideal cases, the bolus of food is placed on the posterior teeth, and the maximum force may be applied when the occlusal surfaces are about 2 mm. apart. This condition is present when there is a normal minimum free-way space of 3 mm. measured extraorally, nose to chin. If a greater free-way space is provided by closing 4 to 6 mm. from rest position, the bolus is compressed at a reduced muscle length and the force is less. The reduced force may be desired for patients with tender ridges.

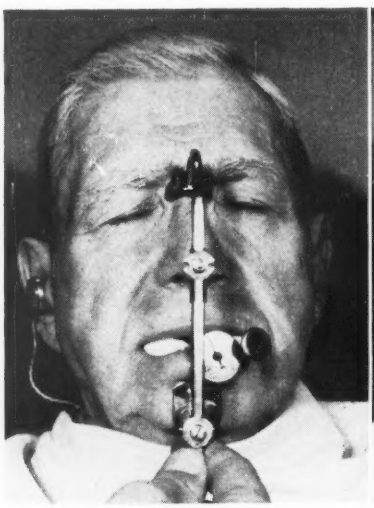

Fig. 2.

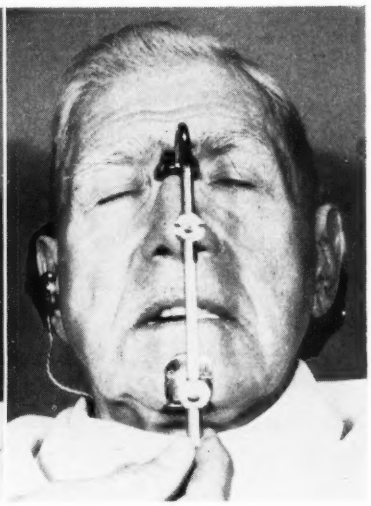

Fig. 3.

Fig. 2.—The maximum biting force as measured by a gnathodynamometer has a vertical dimension of 128 mm.

Fig. 3.—The vertical dimension at rest position is 128 mm. and is the same as the maximum biting force.

The free-way space may be varied according to desired conditions of force and esthetics, but it must never be reduced to less than 2 mm. The patient must have a space between the teeth when he rests or there will be tension of muscles.[2]

A physiologic centric relation may be obtained by closing from rest position in a normal unstrained hinge axis. In the majority of patients, about 65 per cent, this centric relation established by closing from rest position will coincide very closely with the centric relation indicated by the unstrained apex of the needle-point tracing or by the unstrained posterior hinge axis.[3]

In the remaining 35 per cent of patients, there is a tendency for the jaw relation to be forward of the posterior terminal position. This was indicated by the gnathodynamometer recording of maximum biting force in a free horizontal range. These registrations recorded as much as 20 pounds greater force in other positions than the posterior position. Some of these areas were as much as 7 mm. protrusive from the most retruded jaw position. For this reason, I have been using rest position as the reference position for centric relation. Rest position is the neutral center of the masticatory musculature, and closing from that position includes a coordination of muscle function.

The use of the apex of the needle-point tracing, or posterior terminal hinge axis as a centric relation, would apparently be successful if good anterior and lateral balance of occlusion is provided. In this way, the patient would be able to masticate within the area included in the balance of occlusion. The patient might not use the centric relation provided for centric masticatory occlusion, but he would be free to move the mandible into any area he desires. Care should be taken to recognize the extent of movement which might be necessary, as it may be as much as 7 mm.

Bilateral balance of the mandible is obtained by eliminating any force in registration and avoiding any resistance which might tip the mandible laterally or up in the anterior or posterior sections. An unstrained position of the condyle in the temporomandibular joint follows as a natural sequence to unstrained registrations and occlusions.

DENTURE TECHNIQUE

With the preceding principles in mind, a complete technique for denture construction makes use of a preliminary impression, a spacer tray, and a nondisplacement final impression. Wax interocclusal records of centric and protrusive jaw relations, a needle-point tracing, are made. These are followed by a trial set-up of teeth and plaster registrations of rest position, processing of the dentures, and recheck milling.

The preliminary impression is obtained by selecting a metal edentulous tray, which is adapted to the mouth form and trimmed about 2 to 3 mm. short of the mucobuccal fold and attachments of the frenula. The postpalatal seal area is examined and classified as to throat form. (Class I is the flat extended throat form permitting a rather large area for the postpalatal seal. Class II is a modified drop of the tissue curtain posterior to the vibrating line between the hamular notches. Class III is an abrupt drop of the tissue curtain which limits the area of the postpalatal seal to a specific area.) The tray and impression should always extend past the final postpalatal seal area. As much area as possible, limited by the throat curtain, should be included in the impression.[4] The tray is lined with a small roll of wax or modeling plastic around the border and across the palate for retention of the impression material and for stops. Alginate is the material preferred for the preliminary impression because it does not displace tissue and it records fine detail. The disadvantages of alginate are in its border weakness and its questionable accuracy in bulk. Soft modeling plastic may be substituted for it. The upper tray is seated with a finger in the vault of the tray and the patient is instructed to bring the lips and cheeks down over the tray with his own muscle power. The jaw is moved laterally to trim the distobuccal angles around the tuberosities. The patient is instructed to suck on the finger that holds the tray in order to mold the postpalatal seal area. The impression is removed and poured in artificial stone immediately. Care must be taken to preserve the borders. The lower tray, with the alginate in place, is seated by holding the tray with a finger on it in the molar region on each side. The labial and buccal borders are trimmed by having the patient bring the cheeks and lips up by their own muscle power. The tongue is wiped on the cheeks, over the lips, and then pressed against the thumb of the operator to trim the lingual border. These same

movements are used in the final impressions. The impression is removed and poured immediately in artificial stone.

The outlines for the individual spacer trays are made with indelible pencil on the casts. On the upper, the tray line is approximately 3 mm. short of the mucobuccal fold. The postpalatal seal area should be examined in the mouth, and the flexion line of the soft tissue marked on the cast. This is usually in the area between the hamular notches and over the fovea palatinae, the two little depressions near the median line. The tray should extend past these landmarks approximately 2 mm. To construct the spacer tray, a thickness of baseplate wax is adapted to the cast without thinning it. The surface of this wax is coated with powder, and a second piece of wax is adapted over it and trimmed to the original outline. The second piece of wax is the pattern for the individual tray which is made of metal or acrylic resin. An autopolymer resin or a good properly processed acrylic resin may be used. Inferior acrylic resin, improperly processed, may warp and continually change its shape.

The lower tray is made in the same manner, by use of a spacer, and being kept within the established border. Handles are placed on the trays for convenience in removal. Wax occlusion rims are placed over the posterior segments of the trays, leaving the anterior section open for tongue movement.

An all-wax occlusion rim is adapted to the lower cast to provide the wax interocclusal record of the maxillomandibular relation for mounting the needle-point tracer.

The patient, previously instructed about conditioning the supporting tissue and musculature, will have had the old dentures out of the mouth for the required period of time at the next appointment. The trays are tried in the mouth and examined for any overextension. Any necessary trimming is completed, and holes are drilled in the palate section and over the crest of the lower ridge with a No. 10 round bur. In the upper tray, two holes on each side lingual to the ridge and one in the palate are sufficient. On the lower tray, two holes are required on each side over the crest of the ridge. The occlusal surfaces of the wax occlusion rims are softened, and the trays are placed in the mouth to register a jaw relation. These wax occlusion rims are used only to hold the trays in place during the border molding (Fig. 4).

A wax which softens at approximately 95° F., such as the Iowa wax, is used to record the borders at the mucobuccal fold and the postpalatal seal area. The wax is brought to its melting point in a vessel which will permit dipping the borders of the tray into it. Hot water is a good medium for heating the wax. The borders of the tray are dipped alternately in wax and in cold water. This method permits a rather fast building up of the wax borders. A small brush is used to fill in deficient areas of the wax borders of the tray. Approximately 3 mm. of wax is added to the entire border and the postpalatal seal areas. An effort is made to confine the wax to these areas. Excess wax on the tray is trimmed away with a knife. Usually, the lower tray is covered with wax, then the wax over the center of the ridge is removed, allowing the wax to remain on the border. Both trays are carried to the mouth and held in place for a period of time to permit the heat of the mouth to bring the wax to a moldable soft consistency. The patient

then molds the borders by bringing the cheeks downward and sideways by muscle force, then sucking on the finger to shape the postpalatal seal (Fig. 5). To form the vestibule buccal to the tuberosity, the mandible is moved from side to side. The tray may be removed and checked for overextension in any place. Any overextension is reduced, and the border molding is continued by adding wax as indicated

Fig. 4.

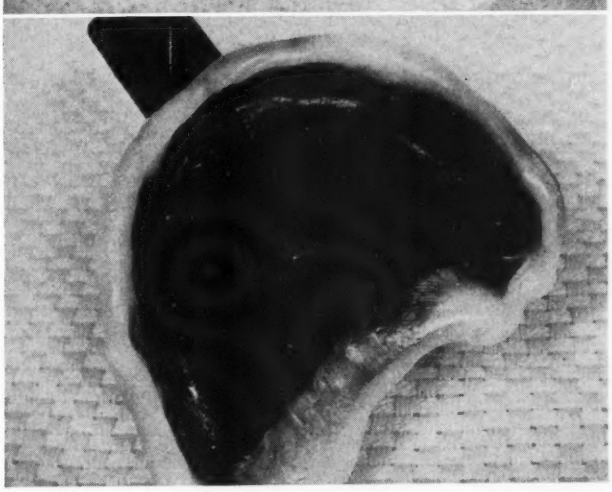

Fig. 5.

Fig. 4.—The spacer trays with the wax occlusion rims in place in the posterior region of the mouth. The jaw relation is established to provide the position for closed mouth border molding of the soft wax borders.

Fig. 5.—The acrylic resin spacer tray with soft wax on all the borders.

and molding by muscle action until a definite mucobuccal fold and postpalatal seal are registered. The border thickness should not be overextended or overthin, and the wax should not be carried into the ridge or palate areas. Any excess wax on the tray is cut away.

The lower impression procedures are very similar to those for the upper impression. The spacer tray is tried in position to see that there is no overextension.

Soft impression wax is placed on the entire border, and the patient registers the limiting tissues in function. This is done by raising the cheeks and extending the tongue over the lip, and the near surface of the cheeks. The tongue is forced against the thumb in the anterior region. The impression is removed, checked for overextensions and for accurate registration of the functional border. Additions and corrections may be made until an accurate functional border is registered. The retromolar pad should be registered in its normal position without displacement.

FINAL IMPRESSIONS

The mouth is prepared for the final impression by washing off the tissue with cotton swabs soaked in saline solution or a mouth wash. The mucous membrane is then dried by gauze. The final impression is made in a zinc oxide and eugenol impression material or in a plaster composition type of material. These materials are used to record tissue detail and to avoid any displacement of tissue on the ridge or palatal surfaces. Wax does not register tissue surface detail. The wax area may show through on the borders, but any area on the ridges or in the palate which shows through the impression requires a correction or a second impression. The tongue and cheek movements used in the functional trimming are used again for the final impression. The impression should record a functional border with slight displacement and accurate detail of the remaining denture area. No tray stops are used.

At this same appointment, the wax interocclusal record may be made. The occlusal surface of the occlusion rim made on the primary cast is softened, and a soft roll of wax is added on its occlusal surface. This is placed in the mouth, and the patient is directed to close until he has passed the rest position approximately 3 to 5 mm. An effort is made to have the mandible in a retruded position. This registration is used to mount the casts on an articulator, to facilitate the location of the needle-point tracing apparatus. The tooth shade or shades and tooth mold are recorded with reference to the physical characteristics of the patient.

Before the next appointment, stabilized baseplates are made on the master cast. These may be constructed by adapting a baseplate with a spacer on the cast. The spacer is removed, and self-curing acrylic resin is used to obtain close adaptation to the master cast. In this way an accurate fit on the cast and in the mouth may be obtained. Attempts to transfer a baseplate from one cast to another would result in inaccuracy of fit in the mouth and loss of accuracy in seating on the casts. The needle-point tracing apparatus is mounted on the stabilized bases with a central bearing in the approximate center of the lower ridges.

JAW RELATION TRACING APPARATUS

Various types of tracers may be used, all of which have advantages under certain conditions.[5] An extraoral needle and tracing plate, with a central bearing point centered in the lower arch, and the bearing plate in the upper arch, provides many advantages. The tracing may be readily observed, and the relative position of the mandible easily located on the tracing in various movements. By having the central bearing point attached to the lower occlusion rim, the approximate

center of the area may be located, and an equal bearing provided. On the upper baseplate, the bearing plate is in the palate between the ridges, and this provides stability for the recording base.

An intraoral needle-point tracing apparatus will provide more stability of the recording bases when the bearing point and tracer are located on the lower base, and the bearing or tracing plate are on the upper base. The difficulty of having the bearing point or tracer located on the upper record base is that the bearing point may be located so far from the center of the lower base that, in some of the movements, the lower base may be unseated. For instance, in a protrusive movement, the upper bearing point may be so near the back edge of the lower bearing plate that the lower base would be tipped up in the anterior region.

In this technique the extraoral tracer is used with a central bearing point on the lower base and a bearing plate on the upper base.

PATIENT JAW RELATIONS

At the next appointment, the maxillomandibular relation is established. First, the vertical dimension for the patient is considered. These considerations include the vertical dimension of the previous dentures, the esthetics, the condition of the patient's ridges, and the operator's judgment of what muscular efficiency to give the patient. The vertical dimension of the previous dentures should be measured for reference and comparison. The occlusal vertical dimension is established at a level 3 mm. closed from rest position to provide the ideal and maximum of efficiency. At this point, the patient will be able to masticate with maximum force, and the appearance may be ideal.

A measurement of the indicated occlusal vertical dimension is made and compared to that of the old dentures. If the change is greater than 5 to 6 mm., it is best to proceed cautiously, as considerable adjustment to the increased height would have to be made by the patient. Masticatory habits as well as adjustments by the lips and tongue may be difficult. If it is determined that the patient will adjust to the ideal vertical dimension gradually, it may be suggested that the patient have treatment dentures which would approach the ideal halfway. Then a year or so later the ideal occlusal vertical dimension can be built into new dentures.

Consideration must be given to the ridges and the type of patient. If it appears best to reduce the amount of biting force, this may be done by increasing the free-way space. If the occlusal vertical dimension is closed 5 to 6 mm. from rest position, there will be a considerable reduction in biting force. This may be an advantage for people who complain about tender ridges. As long as the vertical dimension registration permits a free-way space, and the patient is conscious of this space, the vertical dimension will not be open too far. The conditioning period which the patient went through with exercises will facilitate the registration of rest position, the amount of free-way space, and the needle-point tracing.

After the vertical dimension has been determined, the needle-point tracing is used with a tracing fluid on the bearing plate. The patient is instructed to move the mandible forward and back a number of times, then from back to each side until a definite (Gothic arch) tracing is recorded. This provides a record of

the extensions of the horizontal movements of the mandible. Then tracing fluid is placed over the bearing plate again, except at the apex of the tracing. The needle used for making the tracing is secured with wax. The patient is then instructed to move the jaw from rest position to contact with the central bearing point in a tapping movement. This will mark the area of closure from rest position in a vertical function. The recording is then two dimensional, vertical and horizontal. These marks are examined to see whether or not they are in the area of the apex of the needle-point tracing. If the marks are protrusive or lateral to the apex, there will be a large functional range, and the patient may not use the apex of the needle-point tracing for mastication. Those cases having a large functional area should have posterior teeth with a mechanical, flat type of occlusal surface. There also should be a horizontal overlap of the anterior teeth equivalent to the distance from the apex of the tracing to the contact point of tapping.

CONDYLE PATH

A registration of protrusive jaw position is recorded to adjust the condylar guidances on the articulator. This is done by having the patient protrude the mandible and recording the position with plaster of Paris. The patient must make a straightforward protrusive movement to record the true condyle paths. A protrusive combined with a lateral movement records incorrect condyle paths. The centric relation is recorded by having the patient move the mandible so that the tracing needle is at the apex of the needle-point tracing and making a registration in plaster. A face-bow is used for the orientation of the casts on the articulator.

Another method for registering the path of the condyles is by roentgenograms.[6]

The laboratory procedure requires the selection of the articulator most familiar to the operator. The first cast is mounted in the position indicated by the face-bow, or, if the articulator is designed on the spherical theory of occlusion, it is mounted according to the principles of the articulator. The second cast is mounted according to the plaster interocclusal record with the tracing needle at the apex of the needle-point tracing. The condyle paths are adjusted to conform to the protrusive registration.

TOOTH ARRANGEMENT

Too much importance cannot be placed on tooth selection and arrangement. This is a most important study in itself, and every effort should be made to utilize the advantages of arrangement. Many times a patient will be satisfied with dentures because of their esthetic effect alone.

There are many principles which may be included in the set-up and balance of occlusion, such as the arcs presented, the Bennett movement, various types of adjustable instruments, and other factors. Any one of these is most important unto itself. At this time, primary consideration is given to other essentials. If the vertical dimension is normal, the height of the occlusal plane may be established at approximately the height of an arcuate line extending horizontally forward from a point about 2.5 to 3 mm. below the top of the retromolar pads (Figs. 6 and 7).

Another more recent essential in tooth arrangement is the establishment of a physiologic arch form. This is somewhat contrary to the rule of setting all of

the teeth directly over the ridge. The teeth, including the bicuspid and anterior teeth, may be set in the normal position of natural teeth, regardless of the fact that they may be off of the ridge. This will establish a more normal function of the superficial layer of facial muscles. Esthetics and phonetics may be more normal for the patient. Extremes may not be tolerated, and it is necessary to use judgment in the application of this principle.

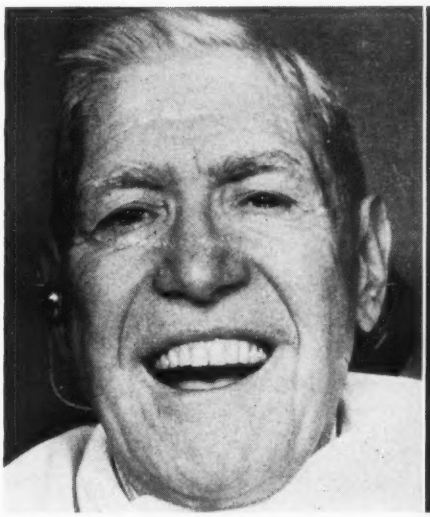

Fig. 6.

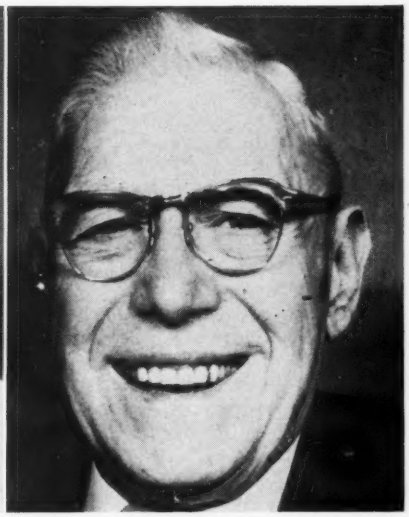

Fig. 7.

Fig. 6.—The teeth of the old dentures have a hanging appearance due to the occlusal plane being too low.

Fig. 7.—The new completed dentures. Note the occlusal plane level and the physiologic tooth arrangement.

At the next appointment, the try-in of the wax dentures with the teeth set-up is made. Changes in esthetics are affected, and a check is made of occlusion. This check includes the vertical dimension, the free-way space, and the balance of the occlusion. At this appointment, plaster interocclusal records of the position of the mandible at rest are obtained. With the trial set-up in place, the patient opens the mouth, and plaster is placed over the lower posterior teeth. The patient is instructed to bring the mandible to rest position for the record (Fig. 8). A plaster which sets in three to five minutes is used, and a plaster syringe or a small spatula is used to place the plaster on the teeth. At least three registrations are made, and marked in pairs by the numbers 1, 2, and 3 (Fig. 9). Rest position is a reasonably constant position at the time of diagnosis, so the records should check with each other. Should the teeth penetrate the plaster and come into contact with their opponents, the vertical dimension of the occlusion is too great. In this circumstance, all the lower posterior teeth are removed, and new plaster records are made. There must be no interference or contact of teeth through the plaster in this registration.

The plaster records and the trial tooth set-up are returned to the articulator which has the casts in the original mounting. One set of plaster blocks is placed

in position to see if it checks with the original mounting. Each pair of plaster records is then checked. If they check with the original mounting, the needle-point tracing and the relation closing from rest position are at the same position.

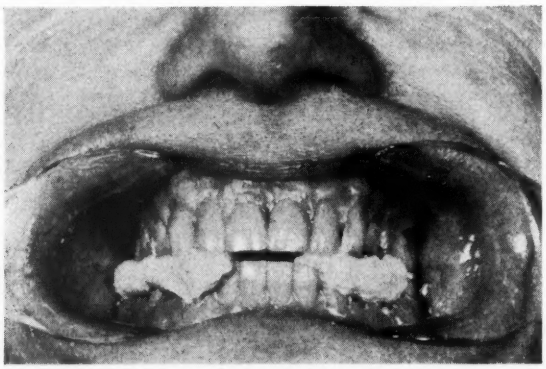

Fig. 8.—At the try-in of the wax set-up, plaster interocclusal records are obtained of the position of the mandible at rest. Note the free-way space.

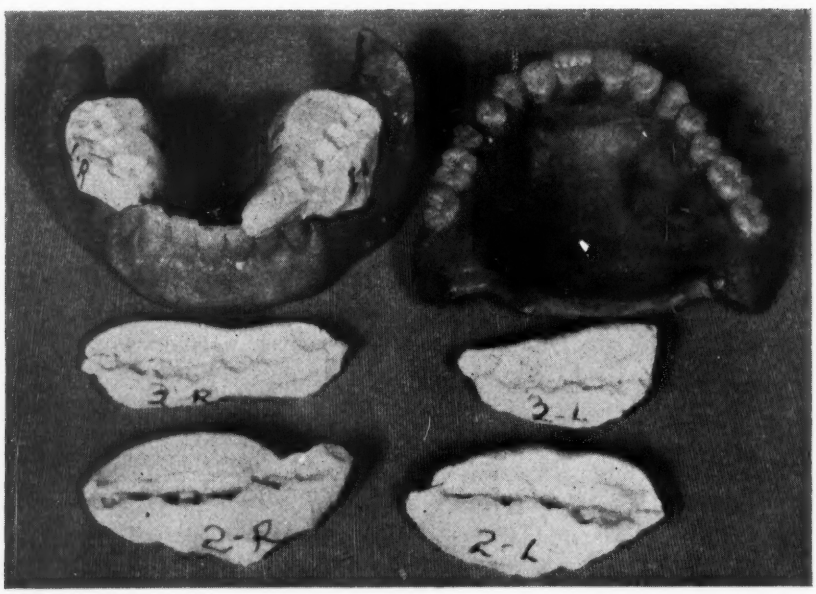

Fig. 9.—Three plaster interocclusal records are made of the rest position at the try-in of the wax set-up.

Under these circumstances, there should be a very satisfactory occlusion of the dentures. Should there be a difference between the plaster records and the centric mounting at the apex of the needle-point tracing, the other plaster registrations should be examined. If the other registrations do not check with the apex, the lower cast should be remounted according to one pair of plaster registrations. The upper arm of the articulator is raised about 4 to 6 mm. above the horizontal posi-

tion for this remounting. The other plaster registrations are then checked to this new mounting, and, if they are the same, this rest position registration is accepted for determining the jaw relations.

The casts are now mounted in rest position. Free-way space is created by closing the articulator from this (rest) position. Three millimeters of free-way space is the minimum; more is used if conditions indicate the need for reducing the biting force. Closure occurs around the hinge axis from rest position. Centric relation is established after the vertical dimension for occlusion is determined. A bilateral balance of the mandible is maintained because the mounting was made at rest position, the neutral center of the musculature, and the closure on the articulator maintains the same length of the muscles. The teeth are arranged in balanced occlusion and then tried in the mouth. The occlusion in the various jaw positions is checked carefully.

POSTPALATAL SEAL AND RELIEF

The postpalatal seal area is located in the mouth between the pterygomaxillary notches, which are located posterior to the tuberosities. The line extends across the palate on the flexion line of the palate. It is usually close to the foveolae palatinae, which are the two small depressions near the median line.[7] The resiliency of the tissues is determined with an egg-shaped burnisher or other blunt instrument. Usually, the lateral surfaces of the palate are displaceable, and the median line covering is relatively nondisplaceable. The postpalatal seal line is cut into the cast with a No. 10 round bur to about half the depths indicated by the probing with the blunt instrument. The anterior edge of the line is scraped out to a tapered depth. The formation of a postpalatal seal on the cast is a controlled displacement.

The relief to be provided over hard areas is determined by examination. Many cases do not require any relief when a nondisplacement technique is followed.

Regardless of the type of material used, it is a good procedure to recheck the occlusion after processing by returning the dentures to the articulator mounting before separating them from the casts.

MATERIALS

Many beautiful materials are available for denture bases. The various pink materials are not only beautiful in color, but the physical properties are reasonably satisfactory. It is necessary to process the materials properly to bring out the physical properties which will best serve the requirements of dentures. The methyl-methacrylate resins require extended processing at a critical temperature, plus a final temperature of 212° F. Cooling should be quite slow. Metal bases are a distinct advantage because of thermal conductivity, accuracy in form and fine detail reproduction. The tinting and characterizing of the plastic materials is one of the important advances in prosthetics.[8] Patients may actually see this improvement, while technical advances are apparent only to the profession. The flexible or soft acrylic resins have a marked advantage when used as a lining material, particularly for lower dentures on sensitive ridges. After careful processing, the dentures are returned to the articulator and adjusted to balanced occlusion.

FINISHED DENTURE PRESENTATION

At the last appointment, the dentures are placed in the mouth and practically no adjustments are made. The steps included in the technique should produce a physiologic function which will be an advantage and comfort to the patient. Sometimes there are old habit patterns from the previous dentures which will reflect themselves in apparent errors of the new dentures, so extensive adjustments should not be made at the original insertion. The patient will eventually function much more efficiently with the new dentures. Within two to three weeks after insertion, plaster registrations should be recorded at rest position, the dentures should be remounted, and the occlusion equilibrated as indicated.

The final instructions to the patient include the hygiene of dentures and the necessity of avoiding occlusion of the teeth as much as possible. The patient should understand that a space has been provided between the teeth when the jaw is at rest; this is the free-way space. Many denture wearers acquire the habit of clenching the teeth to gain a secure feeling. This continual pressure is damaging to the ridges. Most patients should leave at least one denture out of the mouth at night to avoid a pressure on the supporting tissues in this period. Many patients should continue on the relaxation exercise to aid in the elimination of biting habits, and to relax the oral structures and the masticatory system.

SUMMARY

1. Many conditions which affect denture construction require diagnosis and treatment before the impression procedures are started.

2. Conditioning the tissue and the musculature provides a more normal anatomic structure and physiologic function.

3. Principles of nondisplacement, functional denture borders, and tissue detail are included in the impression technique.

4. Vertical dimension, centric relation, and bilateral balance are determined for maxillomandibular relations. The needle-point tracing and physiologic rest position are used as reference positions for diagnosis.

5. Condyle paths are recorded by tracings and roentgenograms.

6. Tooth arrangement follows a physiologic principle.

7. The available denture base materials require careful processing and check-step procedure.

8. Final instructions of hygiene and psychology are made at the time the finished dentures are placed in the patient's mouth.

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PHYSIOLOGIC VERTICAL DIMENSION AND CENTRIC RELATION

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TWO FACTORS WHICH ARE of vital importance in the practice of prosthodontics will be considered in this discussion. They are (1) the physiologic vertical dimension and (2) the centric relation at the natural vertical dimension. Also, three methods used for determining these positions in the average normal patient will be compared: (1) the bruxism method for determining centric relation; (2) the statistical average method for measuring the interocclusal distance; (3) the physiologic method for determining both positions from the function of swallowing saliva.

During the past hundred years, the dental profession has accepted the idea that the horizontal, lateral, and protrusive movements of the mandible were the functional movements used in the mastication of food. Recently, however, it has been shown that these are movements of bruxism which are made when patients rub or grind their teeth during emotional strains or tensions.

One of the current means used in locating centric relation in complete dentures is the tracing of the peripheral lateral movements of bruxism with a central bearing point. In this method, a stylus is attached to the occlusion rim of the lower baseplate and adjusted to contact a flat metal surface attached to the upper baseplate at a given vertical dimension. When the mandible is moved to both the extreme right and left positions, an arrowhead-like tracing is made, the apex of which indicates a centric relation obtained by the extreme right and left movements of bruxism.

Measuring the interocclusal distance is also one of the well-known and currently used methods of determining the vertical dimension for occlusal rehabilitation, occlusal replacements, and complete dentures. In this method, the closed vertical dimension is obtained from the open vertical dimension—that is, if a distance of approximately 2 to 3 mm. exists between the upper and lower incisal edges, after the mandible returns to rest, then it is assumed that an acceptable vertical dimension has been established.

Both of the above methods provide approximations of the positions of centric relation and vertical dimension.

The physiologic method, on the other hand, takes into consideration the individual needs of each patient. It determines the physiologic centric relation and vertical dimension from the constantly repeated function of swallowing saliva.

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THE PHYSIOLOGIC APPROACH

In physiology, there is an axiom that form is determined by function. We may project this thought further and state that the mandibular positions under consideration are determined by functional movements.

That the principal physiologic movements of the mandible are those engaged in the mastication of food is now an accepted fact. Kurth[1] has shown these movements to be in a general vertical direction. Boswell[2] has shown that they are cyclic in nature, and since Jankelson[3] has pointed out that there is little or no occlusal contact when food is interposed between the teeth, it can be readily deduced that the true functional movements of mastication are not factors in determining the positions of centric relation or the vertical dimension.

In swallowing saliva, on the other hand, important mandibular movements take place that *do* enter into the determination of these positions.

During the function of swallowing saliva, the mandible leaves its rest position and rises to the natural vertical dimension of occlusion; then, as the saliva is forced backward into the pharynx by the tongue, the mandible is retruded along with the tongue to its natural centric relation.

The process of swallowing saliva is recognized as a twenty-four-hour function, and it is performed from fifteen hundred to twenty-four hundred times a day. The mandibular pattern of movement is the same for the edentulous infant as it is for the edentulous adult. A similar pattern prevails for natural teeth and artificial dentures.

When the deciduous teeth erupt to form the deciduous dental organ, the occluding surfaces of the upper and lower teeth meet at the level of the natural vertical dimension. Further eruption is held in check by the repeated occluding contacts of the opposing teeth that occur throughout the day during the swallowing of saliva.

A similar pattern of eruption and occlusion holds true for the adult dentition. As teeth erupt intermittently, beginning at the age of 6, and continuing on until the age of 17, the eruption of each tooth is halted at the natural contacting level by its opponent in normal cases. It should be remembered that the six-year molars have been contacting and adjusting to each other for a period of six years before the second molars erupt to occlusion.

It is readily deductible then, that the constant intermittent occlusal pressure that occurs during the swallowing of saliva prevents further eruption of the first and second dentitions, and that normal occlusion takes place at the physiologic vertical dimension.

Complete dentures, occlusal restorations, and occlusal replacements should also occlude at the natural vertical dimension during the physiologic function of swallowing saliva.

With the loss of natural teeth, patients frequently become edentulous in or about middle life. During this transition, the musculature generally undergoes certain degenerative changes. Although the pattern of swallowing remains the same, the reflexes lack the sharpness of earlier days. Just note the fumbling of words by middle-aged commentators, and how frequently older persons bite the tongue, lips, and cheeks. Therefore, in determining the vertical dimension and

centric relation for middle-aged and elderly patients with uncertain muscular reflexes, considerable care must be exercised to select the appropriate swallowing level and to be certain that it has an accompanying interocclusal distance.

The interocclusal distance is the gap that is formed between the maxillary and mandibular occluding surfaces as the mandible is lowered from centric occlusion to rest position. Here the mandible remains passive when the person is not engaged in speaking, swallowing saliva, or masticating food. The distance is at its optimum when the Frankfort plane is parallel with the floor. In this position, the mandibular occlusal surfaces are nearly parallel with the maxillary occlusal surfaces. The interocclusal distance is formed constantly following the swallowing of saliva.

As muscular tonicity decreases with age, the mandible tends to gravitate lower than the rest level of youth so that the interocclusal distance is increased with advancing age.

The interocclusal distance of speech is the interval between the teeth that is formed as the mandible is lowered downward and forward during conversation. When the various sounds are made, the mandible moves to various levels. Words containing the letter *s* require the mandible to move to a high level. It is for this reason that the *s* sounds are used for testing the presence of an interocclusal distance during speech. In saying the letter *m* the mandible moves to a lower level. The Frankfort plane should be parallel with the floor during these tests.

In the physiologic method for determining the vertical dimension, tests are made routinely for the presence of these spaces after the vertical dimension has been established.

Mandibular positions are readily influenced by posture and tension. Therefore, in recording mandibular positions, the patient should be as relaxed as possible, with the Frankfort plane paralleling the floor.

Tests with the electromyograph, by Harry and William Shpuntoff,[4] have shown that the muscles controlling the mandible become tense when any type of mechanical recording device is placed in the mouth or on the head. A record of a mandibular position made under such circumstances would reflect the strain so induced. For example, if a centric relation record is made with a central bearing point, it will be a centric relation record plus the strains induced in the musculature and the organs of the mouth by the instrument.

One of the advantages of the physiologic technique that follows is that the muscles and the organs of the mouth undergo very little strain when the thin casting wax or very soft wax is placed on the occlusal surfaces of either natural or artificial teeth.

THE TECHNIQUE FOR DETERMINING THE PHYSIOLOGIC VERTICAL DIMENSION AND CENTRIC RELATION

The physiologic method for testing and determining the vertical dimension and the centric relation in occlusal rehabilitation, fixed and removable partial dentures, as well as single immediate and complete dentures, is as follows:

The premature contacts that may cause the mandible to be deflected from a normal path of closure are removed first. A simple means for doing this, and one

that is efficient and interferes the least with normal functions, is to place a thin layer of 28 or 30 gauge casting wax over the occlusal surfaces of the lower teeth. Then have the patient close, swallow, and rub his teeth together.

If a buccal cusp perforates the wax, the perforation is evidence of a premature contact. Then the offending part of the lower buccal cusp is marked and removed with a fine stone. If a perforation appears in a central groove or on a lingual cusp, it indicates that the premature contact is on a lingual cusp of an upper tooth. To locate the upper premature contact, remove the wax from the lower teeth and place a thin layer of wax over the occlusal surfaces of the upper teeth. Have the patient close, swallow, and grind his teeth. The offending part of the upper lingual cusp will then appear through the wax. The premature contact is marked and readily removed with a fine stone.

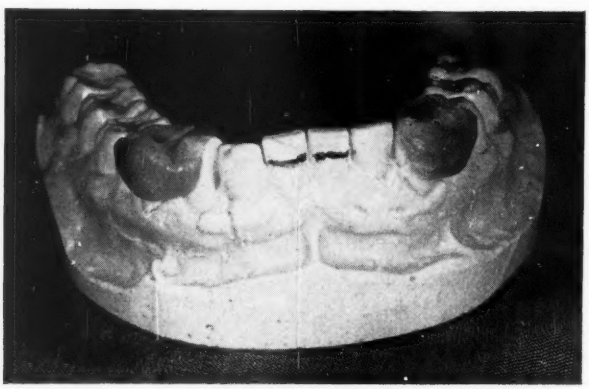

Fig. 1.—The physiologic vertical dimension is tested by placing very soft wax over the lower first bicuspids.

The patient is now ready to be tested for the natural vertical dimension and centric relation, provided the occlusal adjustments were minor. If extensive adjustments were made, it is advisable to wait until the neuromusculature system adjusts to the new conditions.

The method for testing the natural or physiologic vertical dimension and centric relation is virtually the same for all occlusal restorations and replacements at all ages. Procedures may vary somewhat, depending upon whether the patient is dentulous, partially edentulous, or completely edentulous.

To test the complete natural dentition, drape a small ball of very soft (Trubyte Equalizing) wax, 8 to 10 mm. in diameter, over the occlusal surface of the lower first bicuspid on each side (Fig. 1). With the patient relaxed and in a comfortable position, have him swallow several times. Upon examining the wax, if there is evidence that the lower teeth made contact with the upper teeth, then you can be certain that the natural vertical dimension has been retained, and no need exists for increasing it. On the other hand, if it is obvious that the teeth did not make contact during the swallowing function, it indicates that the teeth did not occlude at the physiologic vertical dimension and that the vertical dimension may be increased, regardless of the extent of the interocclusal distance. However, several tests should be made before the final decision is reached.

To test the physiologic vertical dimension in a partially edentulous mouth, drape a small amount of very soft wax over the occluding surfaces of the lower first bicuspids (Fig. 2). Cause the patient to relax in a normal sitting posture. Give him a small piece of candy to suck on, with instructions to swallow the saliva for five minutes. If upon examination of the wax, it is found that considerable wax remains between the upper and lower teeth, it indicates that the teeth do not occlude at the natural vertical dimension, and that treatment may be safely instituted after several tests are made.

If, upon examining the wax, it is obvious that the lower teeth have contacted the upper teeth, it indicates that the natural vertical dimension has been retained. If the interocclusal distance should be in excess of the 2 to 3 mm. average, the natural vertical dimension should not be violated.

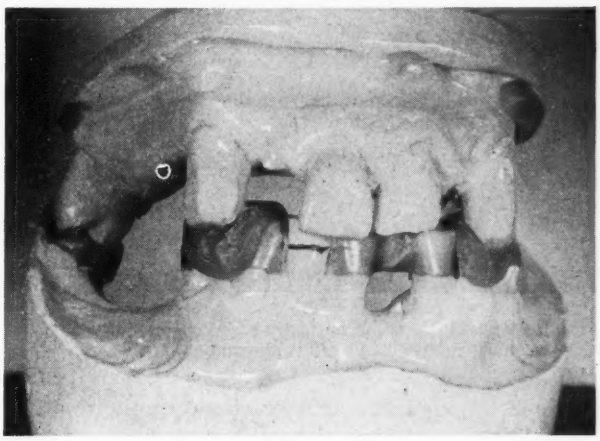

Fig. 2.—Each patient's physiologic vertical dimension and centric relation is diagnosed prior to occlusal rehabilitation.

Tests for complete dentures are made twice, once with the baseplates, and again when the teeth are tried in. To test the vertical dimension with baseplates, first determine the length of the upper teeth on the occlusion rim of the upper baseplate, and then make a tentative vertical dimension registration, using the free-way space technique or any of the usual methods, then mount the casts on the articulator.

To establish the physiologic vertical dimension and centric relation, reduce the lower occlusion rim 2 to 3 mm. Place a ball of very soft wax on top of the lowered rim in the median line, and in the bicuspid areas. Place the upper and lower baseplates in the mouth, and request the patient to swallow several times. As the patient swallows, the mandible is raised to its vertical dimension terminal, and the soft wax is evenly lowered and balanced by the musculature as the mandible is retruded along with the tongue to its natural centric relation. This is the centric relation at the physiologic vertical dimension that is transferred to the articulator for setting up the teeth in centric occlusion.

The second test for the vertical dimension of complete dentures is made at the time of the try-in, by draping a small amount of very soft wax over the lower

first bicuspid on each side (Fig. 3). Cause the patient to relax, and provide a small piece of candy to induce the flow of saliva. Have the patient swallow casually for two to three minutes. If, on examination, the wax reveals that the lower teeth contacted the upper teeth, it indicates that the teeth occlude at the natural vertical dimension.

Ordinarily there is a very thin transparent film of wax—about 1/1,000 of an inch—over the lower teeth at the natural vertical dimension after the swallowing tests. If there is no wax film present, and considerable tooth structure is exposed after several tests, it indicates insufficient closure or an excessively open vertical dimension, and also that the teeth are contacting prematurely.

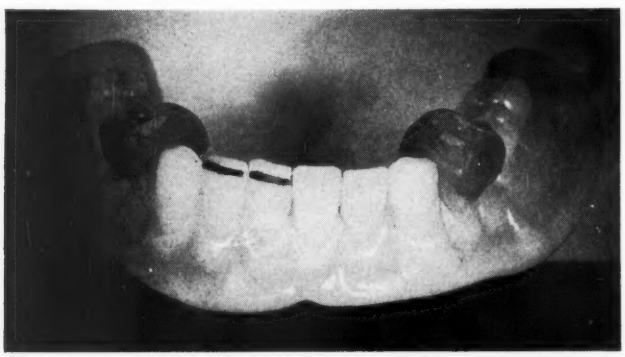

Fig. 3.—The highest speaking line. The testing method is virtually the same for all occlusal restorations and replacements at all ages.

When considerable wax is left interposed between the upper and lower teeth, after the swallowing tests, it indicates that the patient overclosed with the baseplates. The physiologic vertical dimension test should be repeated with the teeth on the baseplates.

The interocclusal distance which is so essential to the well-being of a natural or an artificial dental organ is dependent entirely upon the neuromusculature system and the position of the head. It varies with each individual. In order to be certain that a space does exist between the occlusal surfaces of the teeth after the physiologic vertical dimension has been established, certain tests are necessary.

Two of the current methods for observing the interocclusal distance are to observe the distance between the occlusal surfaces during speech, and when the mandible is at rest, with the Frankfort plane parallel with the floor.

The phonetic test is not tiring to the patient and is simple to make.[5] First draw a horizontal line on a lower central incisor, at the level of the upper incisal edge when the teeth are in centric occlusion (Fig. 1). Draw another horizontal line on the same lower central at the level of the upper incisal edge after the patient has pronounced a number of words containing the letter *S*, such as "yes," "Miss," "fish," etc.

The difference between the centric occlusion level and the high speaking level indicates that an interocclusal distance does exist between the occlusal surfaces when words containing the letter *S* are spoken.

To confirm the existence of an interocclusal distance after the mandible returns to its position of rest, place dots at the point of the nose and chin. Then measure the distance between the dots when the teeth are in centric occlusion. Now ask the patient to repeat the letter *M* a number of times in order to induce the mandible to return to rest, then measure the distance between the dots with the mandible in the open rest position. The difference between the open and closed mandibular positions indicates that an interocclusal distance does exist between the occlusal surfaces when the mandible is at rest. The space does not have to conform to a specific statistical average.

SUMMARY

Prior to the introduction of dental physiology to prosthodontics, the vertical dimension and the centric relation were determined by mathematical and mechanical means.

Today, the basic science of dental physiology is not only being applied as a diagnostic aid, but it is also being applied in determining the physiologic vertical dimension and centric relation.

A method has been described for determining the vertical dimension and the centric relation by physiologic means.

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DENTURE ESTHETICS

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POETRY AND LITERATURE for centuries have indicated that the teeth possess a beauty all their own and also that they contribute greatly to facial beauty. Teeth and the oral area have frequently been modified to enhance one's beauty, to indicate a position of eminence, or to indicate the marital state. The aborigines adorned the teeth with gold and jewel inlays and modified the crown forms by grinding; the Annamites lacquered their teeth black to indicate respectability; the Indonesian women lacquered their teeth red to indicate the attainment of the marriageable age; and the Americans want clean white teeth for dental beauty. Thus, the characteristics of dentofacial beauty are somewhat related to the state of civilization and the geographic area of the world.

The term "esthetics" was coined in 1750 to designate the science of sensuous knowledge which gave beauty, in contrast to the science of logic which gave truth; the term in later years was related to the fine arts as the theory of beauty.[1] In the subsequent two centuries, significant investigations have been made into beauty's essential characteristics, the tests by which it may be recognized or judged, and its characteristic action upon the human mind. The connotations of the term "esthetics" are today as variable as are the peculiarities in the sensitivity and background experiences of the sexes; the number of nationalities and races in the world; or the foibles and freakiness of youth and maturity. Therefore, one should expect all shades of appreciation and recognition abilities from the denture patient and the reviewing public. To determine if such inconsistency prevails in the prosthodontic ranks, we need to sample the definitions of esthetics perfected by prominent master artists in the denture field such as the following:

"Esthetics is the idealizing or harmonizing of the artificial with the natural."[2] "Esthetics is the return to normal vertical dimension."[3] "Esthetics is the natural setting of teeth in the arch plus natural ridge and gingival tissue contours."[4] "Esthetic fundamentals are beauty, harmony and naturalness."[5] "Esthetic fundamentals are beauty, naturalness and individuality."[6] "Esthetics have no formula—a rugged individualist field."[7] "Esthetics is the science which deduces from nature the rules and principles of facial and dental art."[8] "Esthetics is a science with established rules and an art necessitating skill and taste in accordance with esthetic principles."[9]

Such definitions are not lacking in decisiveness, yet they may be interpreted as indicating a measure of disagreement as well as unanimity in views. It is apparent that beauty, harmony, naturalness, and individuality are basic major qualities, with perhaps additional minor qualities tending to give that final touch of discord which yields true artistry.

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An artist is one who creates beautiful things simply by an interpretative recording of his emotions and feelings. Such a person does not necessarily know just how he creates his work of art, for he possesses a native talent and, therefore, rules and regulations are impediments to his progress. One not so blessed with instinct and feeling must rely upon the science of esthetics and clinical practice to develop the skills and appreciations required for success. The following items are important for developing esthetic taste and skill.

PATIENT DESIRES AND DEMANDS

The dentist must understand the wants of denture patients and realize that their wants and needs are not uniform, do not necessarily harmonize, nor do they harmonize with naturalness, age, sex differences, or the fundamentals of esthetics.

Milton Cohen[10] has stated, "It is difficult to overcome the natural antipathy of the patient to a truthful reproduction of his own teeth, where fillings and decay are present, when it is his desire to improve his appearance with newer, cleaner and a better looking arrangement of his teeth." Hooper[11] likewise has stated, "The dental profession is going to be forced to produce more esthetic dentures as the public is becoming more educated to appreciate good looking, well cared for natural teeth—which makes them more observant of artificial teeth."

The dentist should be sensitive to the fact that denture patients want to eliminate from their faces the telltale signs of aging, and thus, allurement and youthfulness are wanted, needed, and will be secured if at all possible. The more truthful age level colors, characteristic staining, and zones of abrasive wear are undesirable and will be tolerated with discomfort, if at all.

The dentist should be sensitive to the fact that an incorrect vertical dimension not only produces facial distortions, but also a facial mirroring of disturbed inner emotions which cause failure. Such facial displays can be erased by proper denture qualities and the correct vertical dimension.

Patients not only want esthetic physical values, but also esthetic functional and facial expressional values. The recognition of these patient demands makes easier the dentist's task of developing an acceptable esthetic taste and creative skill.

OPERATIVE PROBLEMS

Brown[12] states that the denture patient is often accompanied by relatives and friends who have divergent views which make the prosthodontist's problem more difficult than need be. Such divergent views forewarn the dentist of the problems the patients must face after the dentures are inserted and exhibited to the home or friendship circle. These patient associates tend to make the solution of the esthetic problem more easy rather than more difficult, since the dentist has the opportunity to modify esthetic values voluntarily before finishing the dentures instead of making compulsory modifications after inserting the dentures.

The dentist should not force the patient to accept an irregular arrangement of teeth, or a darker and more natural age level color, when the patient's conception demands small, white teeth evenly and symmetrically arranged. Nor should the dentist force the patient to accept denture qualities of any nature which cause constant derogatory appraisals or rejoinders from family or friends.

ESTHETIC VALUES

The dentist should recognize that the demands and objectives of esthetics in denture art are contrary to the demands of esthetics in the pure arts in general. Denture esthetics demand values which do not attract the observer's attention, whereas esthetics in other art fields generally, to some degree, demand values to attract the attention. Natural teeth do, on occasion, intrude themselves offensively on the observer, yet the artificial substitute should be unobtrusive and should be supplementary to the physical and functional cosmetic values of the face.

The dentist should learn to analyze the facial beauty factors associated with an edentulous patient by applying beauty fundamentals, and physical measurement of beauty. Yet Hardy[7] says, "Denture esthetics is not easily reduced to a formula," and Richey[13] says, "The most successful denture artists create their values by instinct developed through earlier [routinism]." Sears[14] says, "Scarcely no field of endeavor, not even art, does not lend itself to analysis." Lowry[8] states, "Dental art is the theory or practise of esthetics in the expression of beauty in form, arrangement and hue of teeth and facial expression."

For hundreds of years, research has been carried on in the field of human reactions to beauty and the physical qualities they recognize to designate a thing or object beautiful. Thus harmony and disharmony, balance and imbalance, symmetry and asymmetry, surface form, color, tone, and movement have been established as significant qualities recognized and used more or less universally to evaluate the relative beauty of a work of art. Likewise, as these item values digress from a mean value they approach ugliness—the countervalue of beauty.

Investigations of the qualities and the patient concepts of dentofacial beauty have been carried out by prosthodontists, orthodontists, and plastic surgeons. Sears[14] projects that the art factors associated with denture esthetics can be analyzed under the heading of face, teeth, and gum. Moller[15] projects an analysis under the headings of gross art values which relate to the face and minor art values which relate to the teeth and denture bases.

FACIAL FACTORS

1. *Physical Facial Values.*—The following items are significant in evaluating relative facial beauty:

   a. The relative over-all size of the face.
   b. The proportions of the face and the ratios of the facial divisions.
   c. The profile of the face.
   d. The outline form of the face.
   e. The mouth size, the commissure length and form, and the form and shape of the angles of the mouth.
   f. The thickness, form, curvature, prominence, and tenseness of the lips.
   g. The creases and folds in the facial tissues.
   h. The squinting of the eyes.
   i. The breadth of the nostrils.
   j. The spatial position of component elements of the face: nose, eyes, mouth, and chin.
   k. Facial impress.

2. *Vertical Dimension.*—This is actually a physical facial value of great importance prosthodontically and esthetically and is solely projected for emphasis. Changes in normal vertical dimension modify the physical and functional relationship which definitely alters their esthetic values. Arbitrary vertical dimension values have been recommended at various times, yet this value is now considered specific to the patient under treatment and as important to facial esthetics as to functional and positional relations of the mandible. Incorrect vertical dimension may so detrimentally modify facial and mouth physical values that esthetic appearance is totally lost.

3. *Functional Facial Values.*—Many authors have pointed out that muscles which function incorrectly distort facial features, greatly disconcerting the patient and creating a poor facial impress. Vertical dimension and denture base bulk have great influence on orofacial functions and upon facial appearance during function.

Too short a vertical dimension, denture base bulk, or recessive anterior teeth cause the lips to pucker and extrude, creating an atypical lip function which is unesthetic and displeasing to patients.

A chin motion excessively upward and forward during speech, comminution, and deglutition yields a bulldog, cross, ill-tempered, and somewhat ugly appearance.

Disturbed function of the eyelid muscles resulting from altered facial muscle functions creates "crow feet" at the outer canthus and drooping upper eyelids, which give a sleepy, demented, and, with men, a feminine facial appearance which is unesthetic and undesirable.

A pained, grievous, uncomfortable facial expression commonly referred to as the denture impress may result from other inadequate and improper physical values which alter functional values.

Many wrinkles and jowl effects are caused by denture deficiencies which permit relaxation of masticatory and facial muscles and facial tissues, which greatly diminishes facial beauty and increases aging of the face.

Fullness of the lips and mouth area: In bygone years, considerable plumpering was used to build out the mouth region, for dentists were then prone to use a reduced vertical dimension. The work of Thompson and Brodie on muscle groups and their chain interrelationship, and that of Brown and other prosthodontists on the need of normal functional length of muscles to improve facial appearance has made obsolete the use of plumpering to improve facial esthetics. The operator should pay attention to the profile of the mouth region to see that it blends with the over-all facial profile, for seldom is it independent of the over-all facial profile.

The dentist, as a facial esthetist and doctor of patient dental health, must judge and mold his denture esthetic values with a knowledge of the existing needs and the natural improvements which occur after dentures are inserted. Thus it is apparent that functional as well as physical conditions bear on facial esthetics.

ORODENTAL FACTORS

Orodental esthetic qualities deal with tooth and denture base characteristics. It seems somewhat false to classify this group of factors as minor factors when they are so important to the lower part of the face.

1. *Physical Esthetic Tooth Values.*—The teeth used should be pleasing and beautiful relative to their esthetic importance and yield naturalness and individuality and blend with the face and mouth in order to contribute to dentofacial beauty. Esthetic values of the lower anterior and posterior teeth relate more to composition values than to individual tooth physical values, such as follow:

Tooth size: The size of the upper central incisor tooth should be in harmony with the face size. Large faces require large teeth, and small faces small teeth for best esthetic values. Dentists often fail to appreciate the attraction power of incorrectly sized central incisor teeth and the esthetic contribution of properly sized teeth. Patients have the false conception that small teeth generally are more pretty, regardless of the face size or the attraction power associated with tooth size. The need, generally, is a plus emphasis for the central incisors and a minus emphasis for the lateral incisors, associated with a near approach to actual needs. Such treatment offers more opportunity to meet the desires of the artist, the wearer, and the observing public.

Tooth outline form: The outline form of the teeth should blend and harmonize with the facial outline form. Facial outline forms resemble rectangles, triangles, or ovals which are basically created by the skeleton form and modified by soft tissue overlay. The soft tissue overlay is somewhat variable according to periods of life, and yet the biologic age level of denture patients largely nullifies the influence of this tissue overlay.

Tooth proportions: The tooth proportion of width to length should closely parallel the facial proportions. Thus the great influence of harmony implies that the proportions of the edentulous face should dictate the proportions of the upper anterior teeth, particularly the central incisors.

Tooth profile: The tooth profile, preferably, should be in harmony with the facial profile curve; however, arrangement possibilities of the teeth greatly diminish this need.

Tooth surface form: The surface form of smoothness or roughness should correspond with the ruggedness and prominence, or lack of them, in facial features. Evaluation of these facial qualities depends upon the emotional stimulation as well as the impression of physical values received by the dentist. A smooth surface tends to highlight and increase the attraction power, and a rough surface tends to scatter the light, decreasing the attraction power. Rough, flat surfaces give the suggestion of strength and masculinity, whereas smooth surfaces give the suggestion of femininity.

Tooth color: Denture patients often exhibit firm conceptions and disagreement with the dentist about the tooth color. Denture patients are more desirous of obtaining the bright, unblemished tooth colors of youth to liven their countenance than they are to secure the darkened, blemished tooth colors characteristic of the denture age or more harmonious with their complexion. The dentist should work toward a compromise value, with minimal compliance with patient desires. Color values can be manipulated to yield very esthetic dentures, since highlights and shadows and brilliance and staggering of the colors are accessory modifiers.

2. *The Arrangement Composition.*—Certain characteristic compositions of the natural teeth frequently occur and are known as typal composition. The classifying terms of square, tapering, and ovoid type have been used to designate these composition patterns, and dentists are quite conditioned to the use of typal terms, yet we could label the arrangement compositions x, y, and z with equal usefulness.

Pure typal compositions are seldom encountered, yet it is necessary to use these basic patterns to work from, when creating blended compositions. Individuality, naturalness, and beauty in the tooth arrangement pattern results from meeting the need for a range in type blending, the atypical and unbalanced conditions associated with asymmetries of development and functions of the lips and mandible. Artistic ability is perhaps more displayed in creating a desired effect in the arrangement composition than in selecting the tooth mold; however, skill in selecting the tooth mold tends to reduce the demand on composition skill.

Typal Composition Patterns.—

Square composition: This composition pattern is rectangular, and the tooth details are more likely to be considered monotonous and devoid of character than are the other compositions. This composition is the one which in the past was labeled the "picket fence" arrangement. This type of arrangement possesses regularity, uniformity and symmetry, massiveness, flat broad surfaces, and flattened curves. The central long axes of the teeth are vertical and parallel to each other and have a minimum of vertical and horizontal overlap. The right and left posterior tooth lines are parallel and devoid of the common distal-tending outward flare. This type has a frequency of approximately 12 per cent of all cases.[18]

Tapering composition: This composition pattern is a triangular arrangement of the teeth with contrast and irregularity predominating. The right and left anterior arch segments converge forward, meeting at the median line, forming a somewhat acute angle. The incisal edges slant downward or upward, giving an irregular incisal line, with either the mesial or distal incisal angle contacting the incisal plane. The inclination of the central long axes is either mesial or distal, with considerable labial inclination. The teeth have varying degrees of rotation, lapping, and vertical and horizontal overlap. The posterior teeth have a buccal inclination, and the lateral arch segment flares outward toward the distal.

This typal arrangement has the greatest variation in details of all types, and some variations are unesthetic, bordering on ugliness, and are not used. This type has a frequency of about 80 per cent of all cases.

Ovoid composition: This composition pattern is curvaceous and pleasing, with the labial tooth surfaces curved gingivoincisally, which gives harmony with the facial profile. The arc of the anterior teeth blends with the posterior flare in such a manner that the cuspid angles in the arch are practically lost. This composition has a characteristic lapping of the incisor teeth and open contacts of the lateral teeth, giving a slight spacing. The incisal edges are on a common plane, and the anterior teeth exhibit a minimum of vertical and horizontal overlap. This type has a frequency of about 8 per cent of all cases, so it is the least frequently occurring, and yet, perhaps, the most pleasing esthetically.

3. *Base Characteristics.*—It should be recognized that the denture base represents the gingival and mucosal tissue of the arch. The denture base, therefore, contributes to oral and facial esthetics in accordance to its bulk, color, and surface characterization.

Denture base bulk: Base bulk can plumper the lips and cheeks to such a degree as to create asymmetry and near ugliness, or it may plumper just the right amount to give a very esthetic effect in the senile or emaciated face. Plumpering is not used today to the same degree as in former years, for greater dependence is placed on correct facial muscle function.

Denture base colors: Only some of the older dentists in practice can recall the troubles and disappointments experienced with pink vulcanite. Present-day denture base plastics have the most acceptable color and translucency of any materials used, except some of the discarded plastics of less stability. With the adoption of our newer plastics, recognition has been given to some of the finer details of gingival and mucosal tissues. Increased and variable pigmentation is being used to give more character and individuality, by dark and light color splotching and by red filaments. Esthetic taste can be expressed in the available base materials without too much difficulty.

Denture base surface characterization: Festooning: The creating of a natural formed gum line and gingival margin about each tooth and about the arches gives a natural appearance, and varying these forms changes the appearance and individuality of the tooth and the composition. Variable effects are created by the relative exposure of the teeth, the curvaceousness of the festoon, by the mesial or distal placing of the acute point of the festoon curve, and by the openness of the embrasure spaces.

Carvings: The creating of raised undulating mucosogingival areas to indicate the presence of the roots gives a more natural appearance and aids in dispersing reflected light.

Stippling: The creating of minute porelike depressions on the surface aids in light dispersion, which increases the natural physical appearance as well as the esthetic appearance.

Polish: Some dentists do not entirely high-shine or polish the surfaces of dentures as in former years. A satiny finish, created by a fine particle sand blasting after polishing, slightly dulls the surface, reducing its mirror reflecting quality, and simulates light stippling.

SUMMARY

Esthetic dentures do not occur automatically, for such is the product of an artist—a denture artist. Such a dentist possesses a premium skill in prosthodontics which should be highly rewarded, for few are natural artists. Denture artistry unfortunately has a relatively short life, for the background and displayment features alter so rapidly as to rob the dentures of their original esthetic values.

Prospective denture artists should realize that an increased sensibility to, and a high evaluating skill of, the physical esthetic qualities in the edentulous face is acquired by much observing of human dentofacial physical beauty values and by the dint of trial and error in creating the desired results by denture qualities. Reading books on art or esthetics and attending lectures are helpful, but the artist must learn to apply beauty fundamentals and develop his esthetic tastes.

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STABLE OCCLUSION RIMS WITH RUBBER IMPRESSION MATERIAL

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THE IDEAL OCCLUSION RIM is one that will fit the cast as accurately as the final processed denture and yet can be removed and reseated without breakage or distortion. In recording jaw relations or checking tooth arrangement, it is essential that the occlusion rims fit as accurately and be stable as possible. To obtain a stable occlusion rim, the shellac baseplate or acrylic resin base must be accurately adapted to the cast. However, where this is done and undercuts are present, either the baseplate or the cast is broken when the baseplate is removed. Therefore, occlusion rims are usually made so that they do not reach into the undercuts, and accuracy of fit and stability are lost.

PROPERTIES OF RUBBER IMPRESSION MATERIALS

The rubber impression materials[1,2] consist essentially of a polyfunctional mercaptan which can be polymerized by certain accelerators or activators to produce a stable synthetic rubber. A comparatively thin layer of the material gives the greatest accuracy, and, properly handled, the accuracy is equivalent to that of a typical hydrocolloid impression material. The dimensional stability of the material is very good where the proper technique is used.

PROCEDURE

The base on which the occlusion rim is built can be either a shellac baseplate or a self-curing acrylic resin. This base is made in the usual way, avoiding the undercuts on the cast. The baseplate is perforated throughout with a No. 703 tapered fissure bur. Particular care is taken to see that there are sufficient holes along the borders and in the upper occlusion rim on the palate so that the rubber impression material will be securely attached to the baseplate (Fig. 1). Meanwhile, the cast is thoroughly soaked in water.

The rubber impression material is mixed according to the manufacturer's directions and placed in the prepared baseplate. The material should be used immediately or it thickens and will distort when the baseplate is removed from the cast. The baseplate is seated on the cast so that there is a thickness of the rubber impression material between the baseplate and cast, not exceeding 3 or 4 mm. The excess material squeezes through the perforations in the baseplate, and this material is spread evenly so that a smooth surface will be presented to the patient's tongue and cheeks (Fig. 2). The rubber impression material is allowed to set thoroughly, and then the lined baseplate is removed from the cast.

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The part of the rubber lining material opposite the crest of the ridge is removed so that the wax occlusion rim can adhere directly to the baseplate (Fig. 3). Then the wax rims are built on the baseplate in the usual manner. The accuracy of the tissue surface of the occlusion rim is equal to that which can be obtained with a hydrocolloid impression (Fig. 4).

Fig. 1.

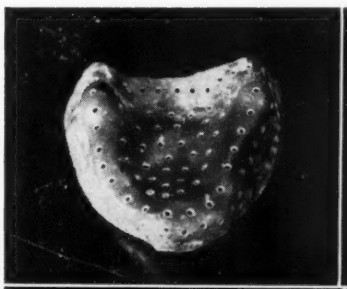

Fig. 2.

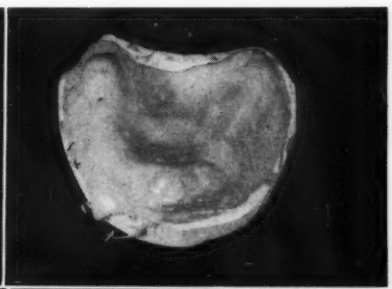

Fig. 3.

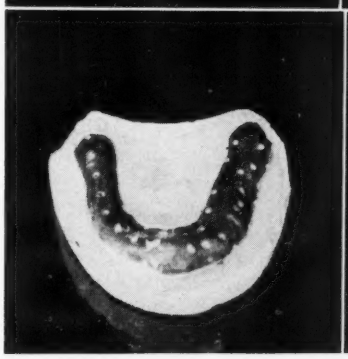

Fig. 4.

Fig. 1.—A shellac baseplate with the necessary perforations for the attachment of the rubber impression material.

Fig. 2.—A cast and baseplate with the rubber impression material spread evenly over the perforated baseplate.

Fig. 3.—The rubber impression material has been removed from the portion of the tray overlying the crest of the ridge.

Fig. 4.—The tissue surface of the occlusion rim showing the accuracy of detail of the rubber impression material lining the perforated baseplate.

SUMMARY

A method for making occlusion rims that will fit with the accuracy of the final denture has been described. Because of the elasticity of the rubber base lining, these occlusion rims can be removed from the casts without damage or distortion, regardless of the severity of the undercuts existing in the casts.

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THE RELATIONSHIP OF ANTERIOR GUIDANCE TO CONDYLAR GUIDANCE IN MANDIBULAR MOVEMENT

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THE SUBJECT OF TOOTH form has been a source of much controversy in recent years. Many dentists cling to the theory that almost any tooth form in the mouth will be satisfactory. They believe the condyle path is not constant; that its path is entirely dependent upon the shape of the anterior guidance. They claim that the condyle of the mandible is a universal joint and therefore will follow any course in which it is directed. Other dentists believe that the condyle path is constant, notwithstanding the shape of the anterior guidance. If the latter is true, then once the anterior guidance, occlusal plane, and compensating curve have been established for a patient, there is just one tooth that will function best for that individual. Which of these conflicting theories is right?

Unfortunately for dentistry, our society meetings and literature have become platforms for long-winded debates. Opinions are expressed emotionally and eloquently without scientific truths as background. Energetic research, and not words, are needed. The following experiment was performed to discover where the truth lies. This study was made to find out the effect on the condylar guidance when the shape of the anterior guidance is altered and when the occlusal vertical dimension is increased. In other words, are the paths of movement of the condyle constant, regardless of its anterior guidance or degree of maxillomandibular opening?

THE EQUIPMENT

The instruments used were the McCollum Gnathoscope and the Gnathograph. Within practical limits, if used correctly, it is possible to record and duplicate the paths of movement of the condyle by means of the Gnathograph and Gnathoscope. Special clutches were cast (Fig. 1). The mandibular clutch was the conventional type. It was made from cast aluminum to fit accurately over the subject's lower teeth, and it held a central bearing pin. The maxillary clutch was made with three interchangeable platforms (concave, flat, convex) against which the central bearing pin of the mandibular clutch could glide during mandibular movements. This clutch was made of cast aluminum to fit over the subject's maxillary teeth and contained a magnet which held the different platforms in position while the mandibular movements were recorded. The platforms were made of a ferrous alloy and were attracted by the magnet. A very snug fit kept the platform firmly in position during all excursions of the mandible.

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THE PROCEDURE

The subject was a well-developed, healthy 25-year-old woman. She had a full complement of natural teeth, except for a missing upper right first bicuspid, which was replaced by a fixed bridge.

The clutches were cemented immovably to the upper and lower teeth. The excess temporary cement was removed and the concave platform was placed in position. The subject was then instructed to move the mandible in every direction with clutches in contact. The height of the central bearing pin was adjusted so that, in any mandibular excursion, the point of the pin was the only contact between the clutches. Thus, the mandible was permitted to move undisturbed in any direction or plane during the various excursions of the mandible.

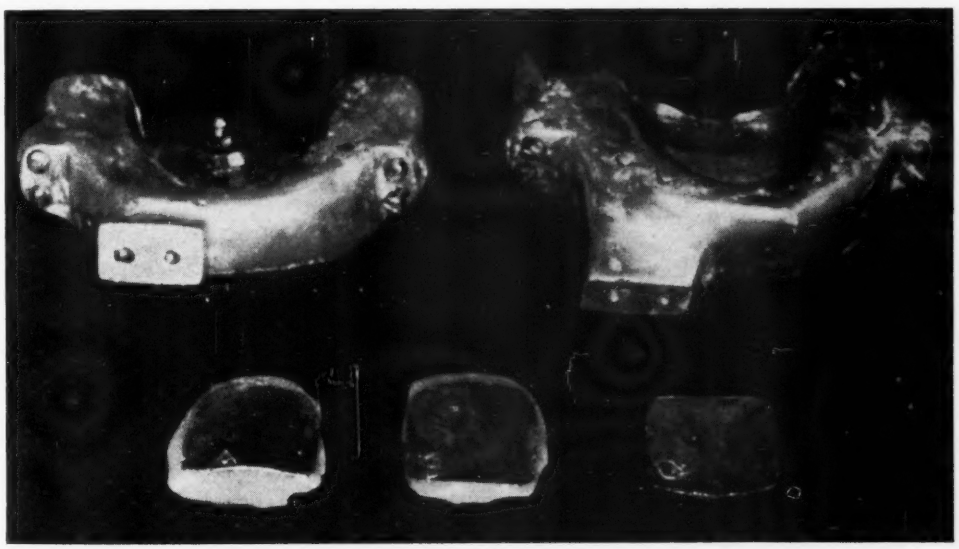


Fig. 1.—The clutches with *A*, convex, *B*, flat, and *C*, concave platforms. Note the central bearing pin in the mandibular clutch and the magnetic seat in the maxillary clutch to hold the various platforms.

The hinge axis was located by means of an adjustable face-bow attached to the mandibular clutch. Points were located in the region anterior to the tragus of the ear on each side, where the point of a stylus attached to the face-bow did not move when the subject opened and closed the mouth while the condyle was rotating on the meniscus in its terminal position. These points were tattooed permanently. A third point was marked on the nose opposite the infraorbital notch. These three points formed a plane of reference, the axis orbital plane, to be used when registrations or casts were to be related to the Gnathoscope.

The face-bow was removed and the Gnathograph was attached to the studs of the cemented clutches (Figs. 2 and 3). The paths of movement of the mandible and condyles were then recorded. The subject was instructed to hold the clutches together all of the time that recordings were being made. In addition to its importance in recording and translating the paths of movement, we wanted the recordings made with the muscles of mastication contracted, so that the con-

dyles would be in positions similar to those of function. The subject was instructed to make three separate and distinct mandibular movements: protrusive, right lateral, and left lateral, with each movement starting from centric position. Three sets of recordings were made. Each was made with a different-shaped platform (concave, flat, convex) against which the central bearing pin would move. These platforms were at different distances from the palate because of their shapes.

Fig. 2.

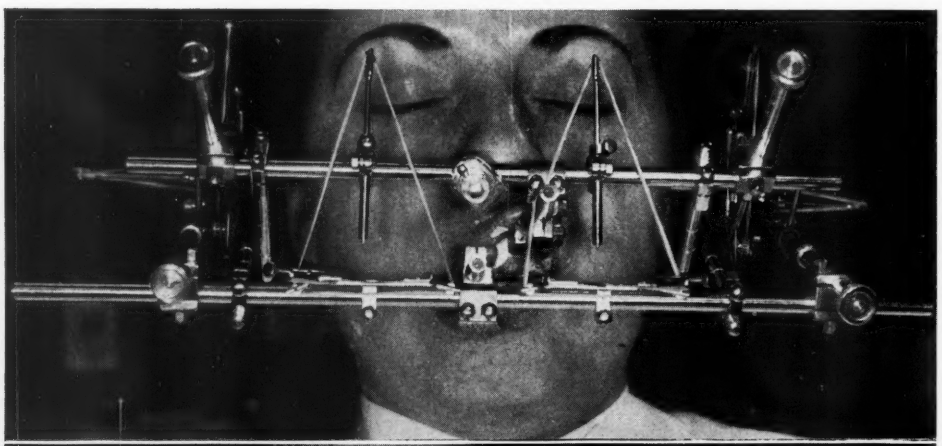


Fig. 3.

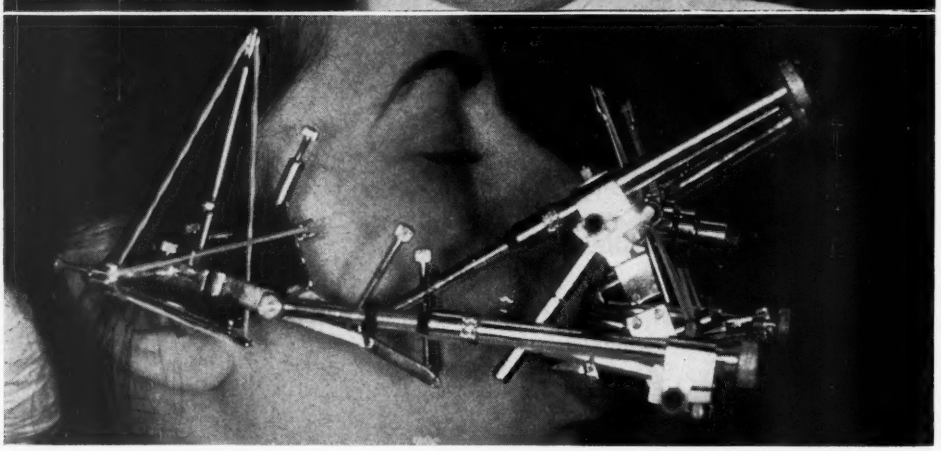


Fig. 2.—The Gnathograph attached to clutches in position on the subject.
Fig. 3.—The Gnathograph in position.

The distances between the various platforms at the centric position of the central bearing pin and the palate were: (1) concave platform, 8.8 mm.; (2) flat platform, 10.2 mm.; and (3) convex platform, 11.7 mm. Thus, between the greatest extremes, there was a difference in the vertical opening at the central bearing pin of 2.9 mm.

ARTICULATOR ADJUSTMENT

With the concave platform in position, and with the *etched glass slides made from the recordings with this platform* locked in place in the Gnathograph, and with the subject in centric relation, the upper and lower halves of the apparatus

were locked in position by means of quick-setting artificial stone. The Gnathograph was thus removed (Figs. 4 and 5). Using the axis orbital plane and the hinge axis of the subject as guides, the Gnathograph was properly mounted on the Gnathoscope (Figs. 6, 7, and 8). By carefully adjusting the Gnathoscope, the instrument was able to follow the condylar paths of movement recorded with the concave platform in position.

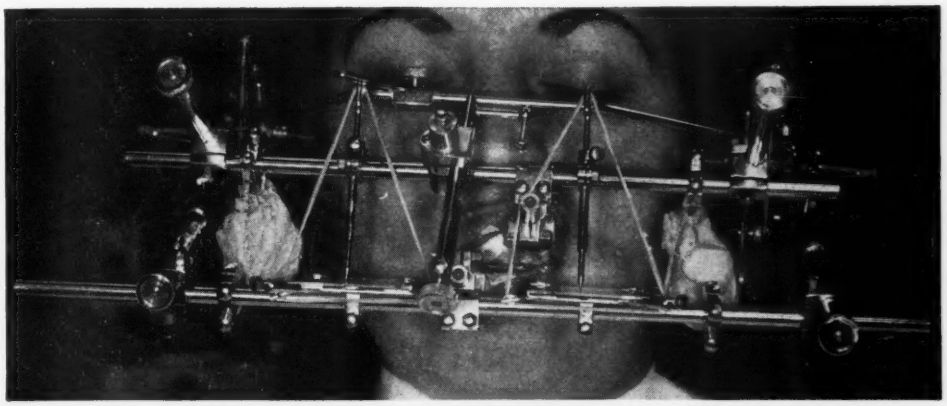


Fig. 4.—The Gnathograph is locked in centric position by means of quick setting stone.

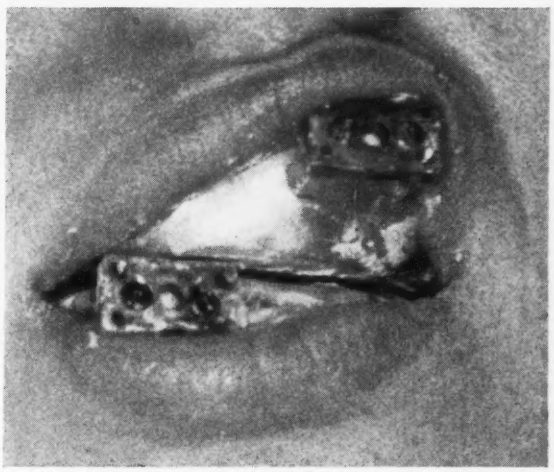
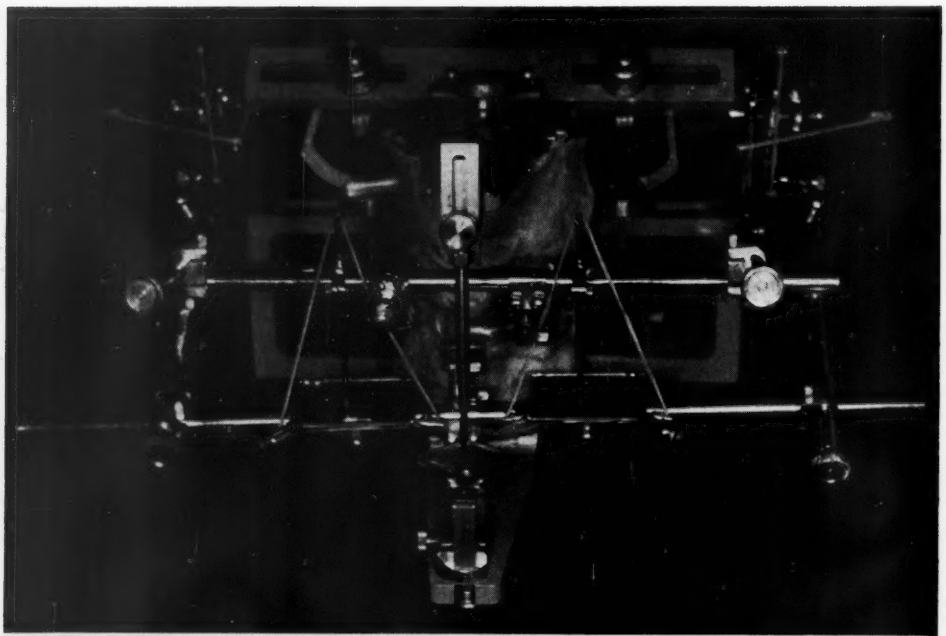


Fig. 5.—The clutches are removed and re-assembled on the Gnathograph before mounting it on the Gnathoscope.

These slides and the concave platform were then removed and replaced with the *flat platform and the etched glass slides made from the recordings with this platform* in position. The first thing noticed before any movements were made on the instrument was that, in spite of the fact that the vertical dimension was opened 1.4 mm., the stylus was exactly at the apex of the needle point tracing in the anterior region. The next thing noticed was that the settings of the Gnathoscope for the movements of the mandible using the flat platform were the same as for the concave platform.

Fig. 6.



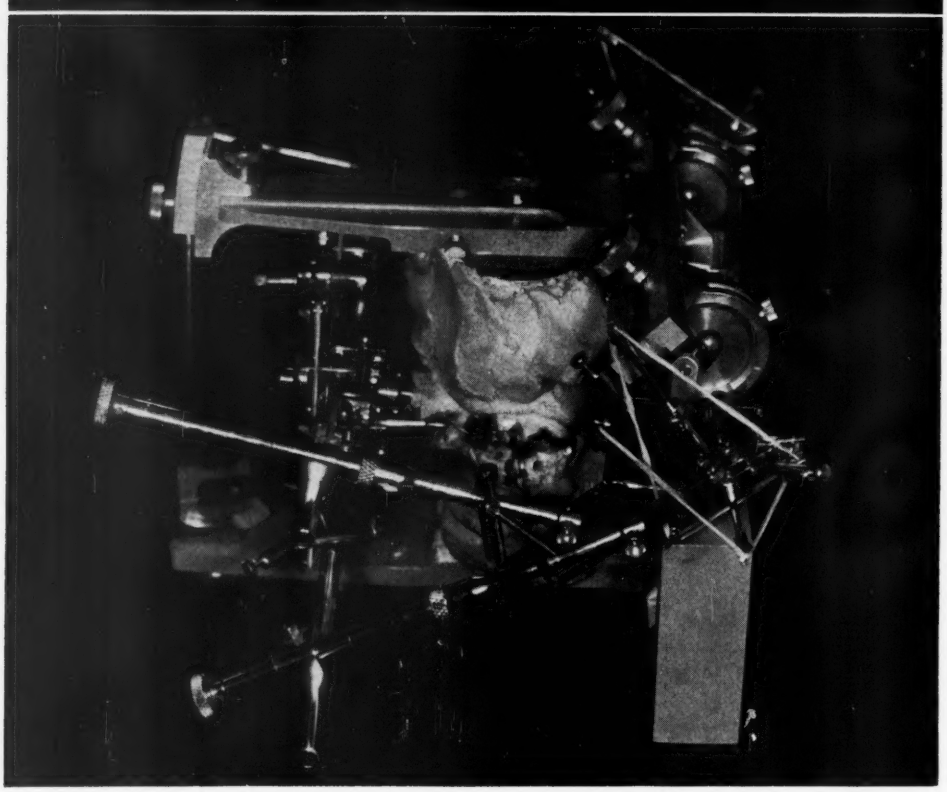


Fig. 7.

Figs. 6 and 7.—The Gnathograph is mounted on the Gnathoscope.

The flat platform and its corresponding slides were removed and replaced with the *convex platform and etched slides made with it in position.* Again we found the stylus exactly at the apex of the needle-point (Gothic arch) tracing even though the vertical dimension had been increased 2.9 mm. We also found that the settings of the Gnathoscope corresponded to the settings made with the concave platform in position.

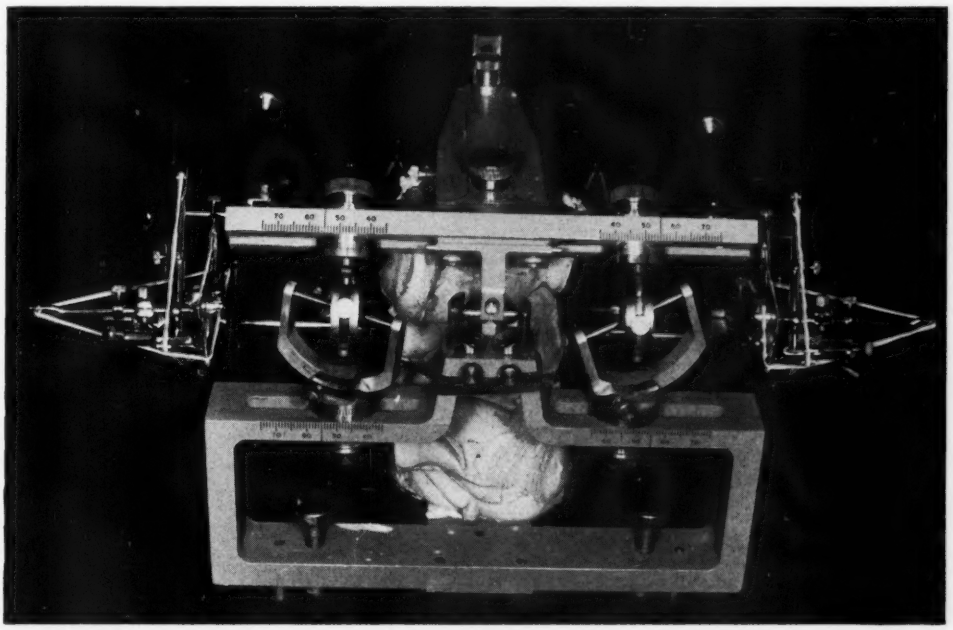


Fig. 8.—Rear view of Gnathograph mounted on the Gnathoscope showing adjustments made to accommodate the tracings registered by the subject.

OBSERVATIONS

A comparison of the etched glass slides made for adjusting the instrument revealed the following:

1. When the three glass slides made in the region opposite the right condyle in the *sagittal plane* were superimposed, the recordings were exactly the same. A comparison of the corresponding recordings on the left side showed the same exactness.

2. When the three glass slides made in the region opposite the right condyle in the *horizontal plane* (which indicates the presence and degree of Bennett movement) were superimposed, the recordings were exactly the same. A comparison of the corresponding recordings on the left side were also identical.

3. When the three glass slides made in the anterior region on the right side in the *horizontal plane* were superimposed, they showed that as the vertical dimension was increased, the apex of the needle-point (Gothic arch) tracing had moved forward. This was also found to be true with the corresponding slides for the left side. This is what we would expect with a hinge movement. However, in every case, with the platform and the needle-point tracing made with it in position (with the Gnathograph mounted in the Gnathoscope), the point of the

stylus was always at the apex of the needle-point tracing. This could occur only if there was a hinge axis on both the patient and the Gnathoscope, and where the hinge axis on both the patient and the instrument were exactly the same.

This experiment shows that (1) within the range of opening of the vertical dimension used, there is no change in the paths of condylar movement regardless of the vertical dimension or the shape of the anterior guidance for the mandible; (2) within the range of opening of the vertical dimension used, there is conclusive evidence of the existence of the hinge action of the mandible.

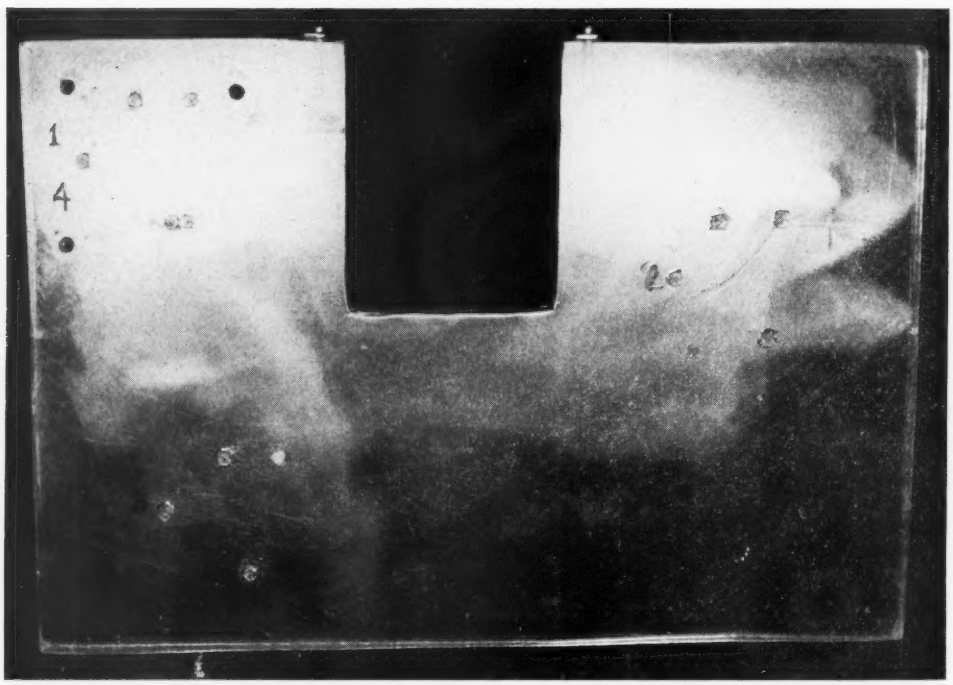


Fig. 9.—The base of the device used to make tracings in the sagittal plane and to illustrate the reason for the difference in projected tracings when the shape of the anterior guidance is altered, and when the vertical dimension is changed. Numbers represent position of the tracings. *1*, At the condyle; *2*, anterior to the teeth; *3*, below the condyle and posterior to the teeth; and *4*, at the condyle guide by tracings *2* and *3*. The notch in the upper center is for the interchangeable platforms. The three holes (upper left) are to mount the fixed condylar guidance.

CONSTANCY OF PATHS OF CONDYLAR MOVEMENT

Granger[2] found the paths of the condyle to be immutable under varying conditions. He used a different maxillary clutch every time he altered a condition (e.g., different shape of guidance plane). McCollum found the same in his experiment.[3]

There appears to be a mistaken notion that since condylar tracings change from one set of conditions to another,[1] the condyle path is not constant. This line of reasoning is incorrect.

Since the condyle path is constant, as has been demonstrated, any change in vertical opening or a change in the shape of the guidance must change the tracing of mandibular movement in the anterior region. An apparatus was devised

to illustrate this point. This device simulates protrusive mandibular movement in the sagittal plane. However, it should be understood that the results and conclusions would be the same for any other path of movement. Even though the lateral and lateral-protrusive paths of movement are the more important ones, the straight protrusive was used because it is easier to illustrate.

The apparatus consists of: (1) a base (Fig. 9) which is a flat piece of clear acrylic resin with places for attaching interchangeable platforms for the incisal guidance (to stimulate the varied shapes of platforms against which the incisal pin rests, e.g., convex, flat, and concave), seats for holding glass tracing slides, and the condylar guidance; (2) convex, flat, and concave interchangeable guidance platforms (Fig. 10); (3) a condylar guidance (Fig. 11); and (4) a simulated mandible with a clutch and three styli. The clutch has an adjustable pin so that there are two levels of vertical dimension, *X* and *Y* (Fig. 11).

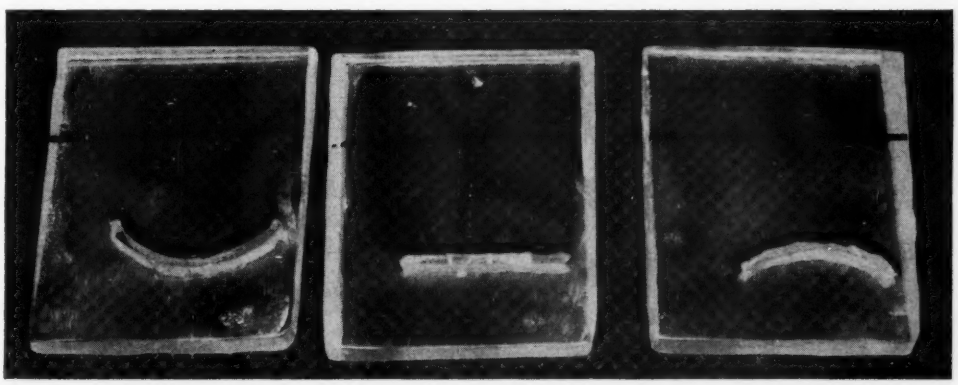


Fig. 10.—The interchangeable platforms *A*, convex, *B*, flat, and *C*, concave.

A series of tracings were made using this device. The condyle was made to follow the same path during all registrations. Tracings were made at the condyle *(1)*, anterior to the teeth *(2)*, and below the condyle *(3)* (posterior to the teeth) (Fig. 12), and in the condyle region, by removing the condyle guidance and the No. 1 tracing and having the mandible follow the No. 2 and 3 tracings (4) (Fig. 12).

Six sets of tracings were made and are shown in Fig. 13.

RESULTS

1. All tracings of the condylar region (No. 1 tracings) were identical. These are the condylar tracings.

2. Every tracing in the anterior region (No. 2 tracings) was decidedly different. There were no two alike. These tracings are not condylar tracings. They are tracings made anterior to the anterior guidance and are the total resultant of condylar guidance and anterior guidance. Since condylar guidance is constant, a change in anterior guidance changes the anterior tracing.

3. The tracings made below the condyle (No. 3 tracings) were all slightly different. The farther we depart from the condyle, the greater is the variation.

Fig. 11.

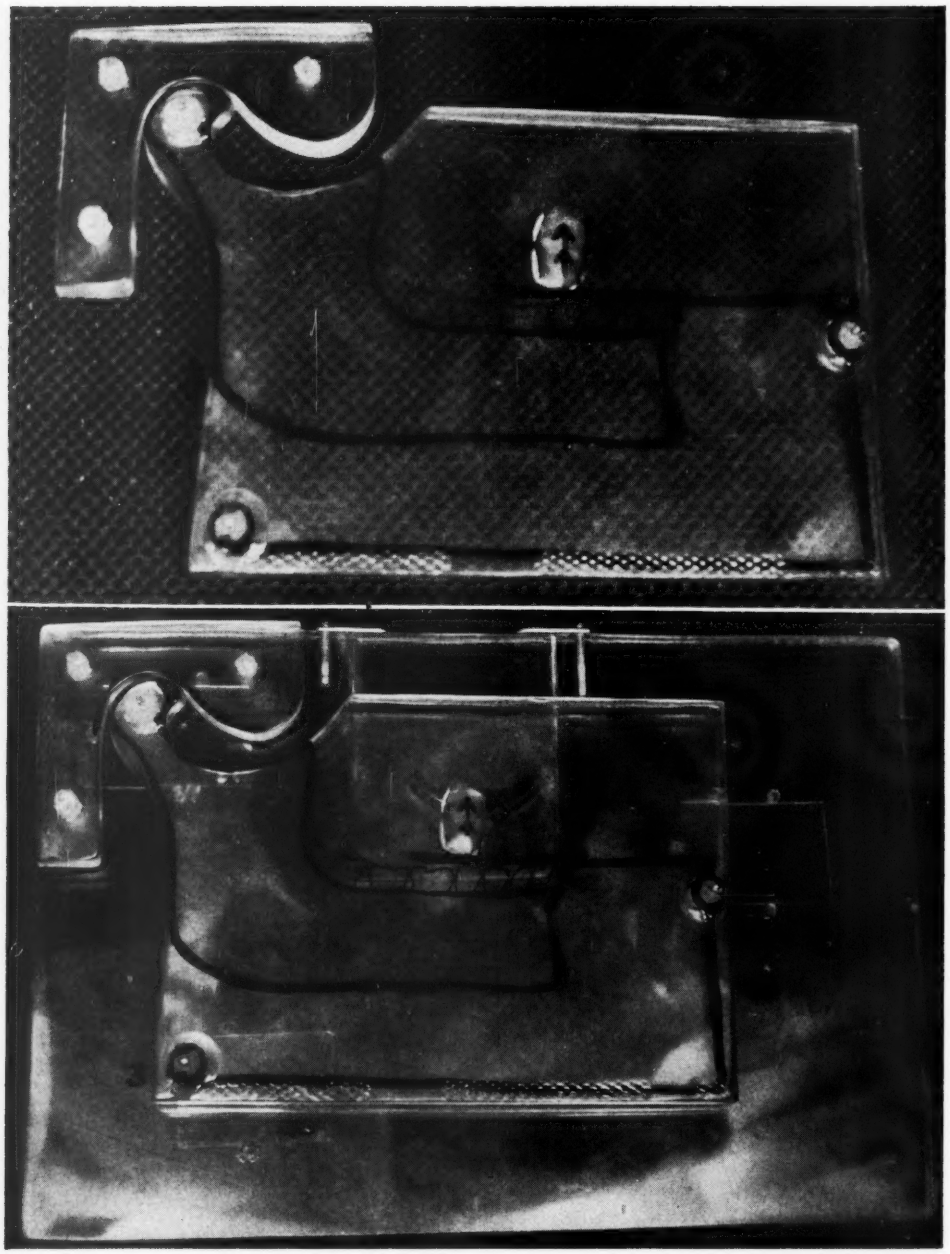


Fig. 12.

Fig. 11.—The basic assembly with the condylar guidance and mandible in position. The simulated clutch is attached to the mandible. The two levels of vertical opening, *X* and *Y*, are established by the interchangeable pins. There are three styli, one (No. 1) at the condyle and two others within circles. One is anterior to the teeth (No. 2), and the other is below the angle of the mandible (No. 3).

Fig. 12.—The entire device is assembled with glass tracing slides in position at *1*, *2*, and *3*.

4. The No. 4 tracings, made when the condyle path and No. 1 tracing were removed from device, and the apparatus was moved to follow the No. 2 and No. 3 tracings, were all identical to each other and to the No. 1 tracings.

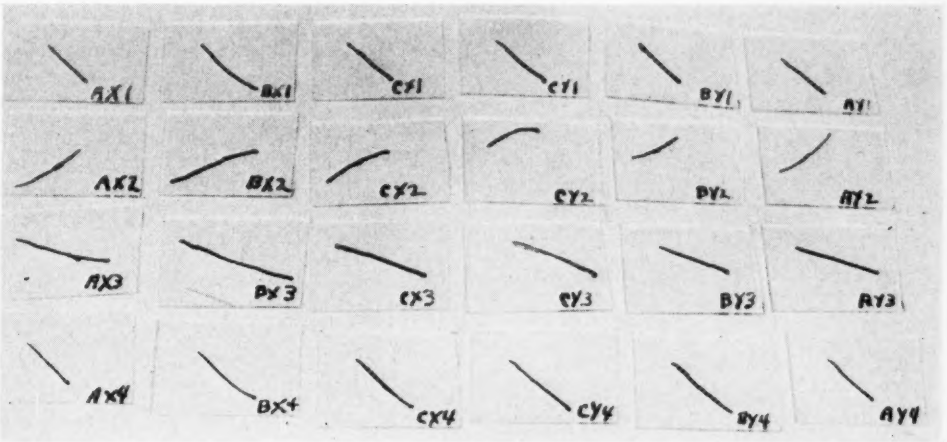


Fig. 13.—Tracings made with the device. The letters indicate the conditions under which the tracings were made, and the numbers (1 to 4) indicate the locations at which the tracings were made. See Figs. 9, 10, 11, and 12. *AX*, Convex platform with the mandibular guidance at level *X*. *BX*, Flat platform with pin at level *X*. *CX*, Concave platform with pin at level *X*. *AY*, Convex platform with pin at level *Y*. *BY*, Flat platform with pin at level *Y*. *CY*, Concave platform with pin at level *Y*.

DISCUSSION

Since condylar guidance is constant, a tracing made in the anterior region must change if the mandibular guidance is changed. The significance of this is that since the condyle moves in definite paths, this factor cannot be disregarded in the diagnosis and treatment of the teeth and their contiguous tissues. The shape of tooth to be used must be in harmony with the guidances.

The paths of movement of the mandible are governed by the condylar guidance and the anterior guidance. We know that in any individual the condylar guidance is fixed and immutable. For further clarification, when we speak of paths of condylar movement, we refer to those occurring in any movement—protrusive, right or left lateral, or any combination of protrusive and lateral. The anterior guidance may be altered sometimes within certain limits. It can be done only when we can change the degree of vertical or horizontal overlap of the anterior teeth. Once the vertical and horizontal overlap of the anterior teeth, the plane of occlusion, and the compensating curve have been established for a given patient, there is one tooth form, and only one, that will function best for that individual.

It is only when we have a thorough understanding of oral physiology, oral anatomy, histopathology, and a working knowledge of the required materials and equipment that we are capable of doing the utmost for our patients.

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A STUDY OF THE INFLUENCE OF OCCLUSAL PLANES ON STRAINS IN THE EDENTULOUS MAXILLAE AND MANDIBLE

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IT HAS BEEN SUGGESTED that certain occlusal forms of artificial teeth may produce lateral stresses of such a magnitude that injury to the underlying bony support may result. Unfortunately, satisfactory procedures for investigating this problem have not been available. Recently, certain techniques for studying stresses in bone have been developed by persons interested in long bones. Of particular interest are the researches done by Gurdjian and Lissner.[1] Accordingly, we have been interested in modifying their methods for dental use. This investigation was designed to ascertain, if possible, the effects of two basic occlusal forms on the edentulous maxillae in simulated masticatory functions.

MATERIAL AND METHODS

Six edentulous skulls, obtained from a biologic supply house, were used in this study. The weight and size of each is shown in Table I. The age, sex, and race were determined by an anthropological consultant,**** and are listed in Table II. No gross pathologic changes were noted in any of the specimens.

The modified method utilizes a strain-sensitive lacquer (Stresscoat) which is coated on the surface of the bone. When this has dried, and the bone is subjected to a dynamic force from .00044 to .00114 in./in., cracking patterns appear in the lacquer. In order to more readily visualize these patterns, a black undercoat is sprayed onto the surface of the bone before the lacquer is applied. When the latter has cracked, an electrolyte is brushed over the surface and the excess wiped away.

A white electrically charged powder (Statiflux) is blown over the lacquer and adheres to the moist electrolyte lying in the cracks and not to the remainder of the surface. This provides a definite white-on-black pattern for study (Fig. 1). The sensitivity of the lacquer is dependent on varying temperature and humidity conditions, and for this reason, a variety of lacquers are used for specific atmospheric conditions.

The patterns, as obtained in dry specimen, are essentially the same as in the living subject, a detail previously noted by Gurdjian and Lissner.[1] In our study,

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TABLE I. THICKNESS AND WEIGHT OF SKULLS

AVERAGE THICKNESS OF SPECIMEN IN MILLIMETERS

SKULL NO.	CRANIUM	MANDIBLE
1	7.4	20.5
2	4.5	16.5
3	5.2	15.6
4	3.5	17.2
5	4.3	13.6
6	5.2	18.7
Average	5.1	17.2

WEIGHT IN GRAMS

SKULL NO.	SKULL	MANDIBLE	TOTAL
1	524.0	88.0	612.0
2	357.2	35.8	413.0
3	416.4	42.6	459.0
4	296.6	51.4	348.0
5	277.5	31.8	309.3
6	427.5	60.0	486.5
Average	383.0	54.9	437.9

TABLE II. AGE, SEX, AND RACE OF SKULLS AS DETERMINED BY AN ANTHROPOLOGICAL CONSULTANT

SKULL NO.	AGE (YRS.)	SEX	RACE
1	42	Male	White
2	35 plus	Male	White
3	42 plus	Male	White
4	35 plus	Male	White
5	42 minus	Female	White
6	30	Male	White

two sets of simulated complete dentures were made for each skull. They were duplicates in all respects except in the form of the occlusal surfaces. One had a 0 degree occlusal plane and the other a 30 degree incline. The inclines were accomplished in the denture base material; artificial tooth forms were not used.

Two to three millimeters of a soft plastic material was interposed between the denture bases and the bones, to simulate the oral mucosa. All of the dentures were stored in 20 per cent alcohol and water between testing periods. The vertical dimension was the same for all skulls in order to keep the torque forces relatively equal.

A testing apparatus was constructed to hold the skull and provide a pulley system for the placement of kilogram weights in the positions of masseter-temporal and internal pterygoid muscles for closing, and the external pterygoid muscles for

lateral and protrusive movements (Fig. 2). A total weight of six kilograms was chosen because it was below the average masticatory forces used by edentulous patients as found by several investigators.[2, 3]

The skulls with their dentures were placed in position on the stand. A U-shaped aluminum strap, lined with leather, was placed under the angle of the mandible. A cord attached to this strap ran up and over a pulley situated above the skull and downward to end in a loop. A one-kilogram weight was hooked into this loop. The same arrangement was made on the opposite side. This served as the masseter-temporal-internal pterygoid muscle pull.

Lateral and protrusive movements were accomplished by means of weight attached to a cord which looped around the neck of the condyle, and ran forward over a pulley system located in front of the skull.

A. *B.*

Fig. 1.—*A*, Detail of the palate, showing stress patterns. *B*, Detail of mandible showing stress patterns.

Another loop was placed around the neck of the condyle, directed backward, and over a third pulley system and down to attach to a hydraulic piston. The latter was designed to act as a shock absorber for the sudden forward movement of the condyles when the weights were attached (Fig. 2).

The skulls were all coated with the lacquer indicated by the prevailing temperature and humidity readings and allowed to dry for twenty-four hours. At that time, each skull was studied for signs of drying cracks which sometimes appear. The crack patterns appearing at each testing period were photographed. The skull was identified by number and the testing session by letter for purposes of identification and later comparison. (The label, Run A, indicated only drying cracks; Run B was for manipulative procedures; Run C, the flat plane dentures; and Run D the 30 degree incline dentures.)

The specimens were then mounted on the apparatus, the dentures properly situated, and the kilogram weights were attached, no attempt being made to move the mandible. The skulls were immediately removed and studied for any strain patterns that may have occurred by the manipulative process.

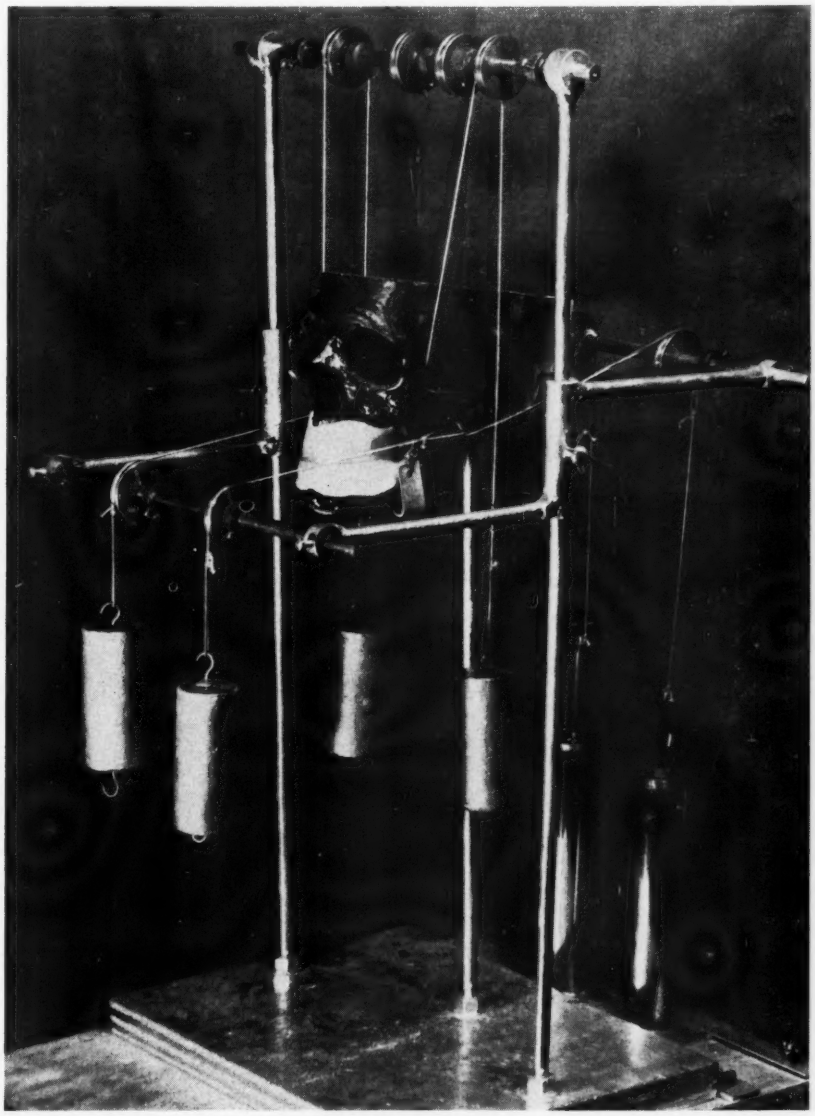

Fig. 2.—Apparatus used for testing. Note the hydraulic pistons attached to the rear of the base.

The skulls were then remounted, the flat plane dentures were placed, and lateral and protrusive movements were accomplished. The resulting patterns were observed and recorded. The same procedure was repeated for the dentures with a 30 degree inclined occlusal plane.

In all of t' preparations, the condyle was maintained at a 2 to 3 mm. distance from the fossa in centric by means of the denture height.

RESULTS

The strain patterns as obtained at the various testing levels indicated the following:

1. Forces transmitted by dentures to the bone are not limited to the maxillary or mandibular residual ridges.

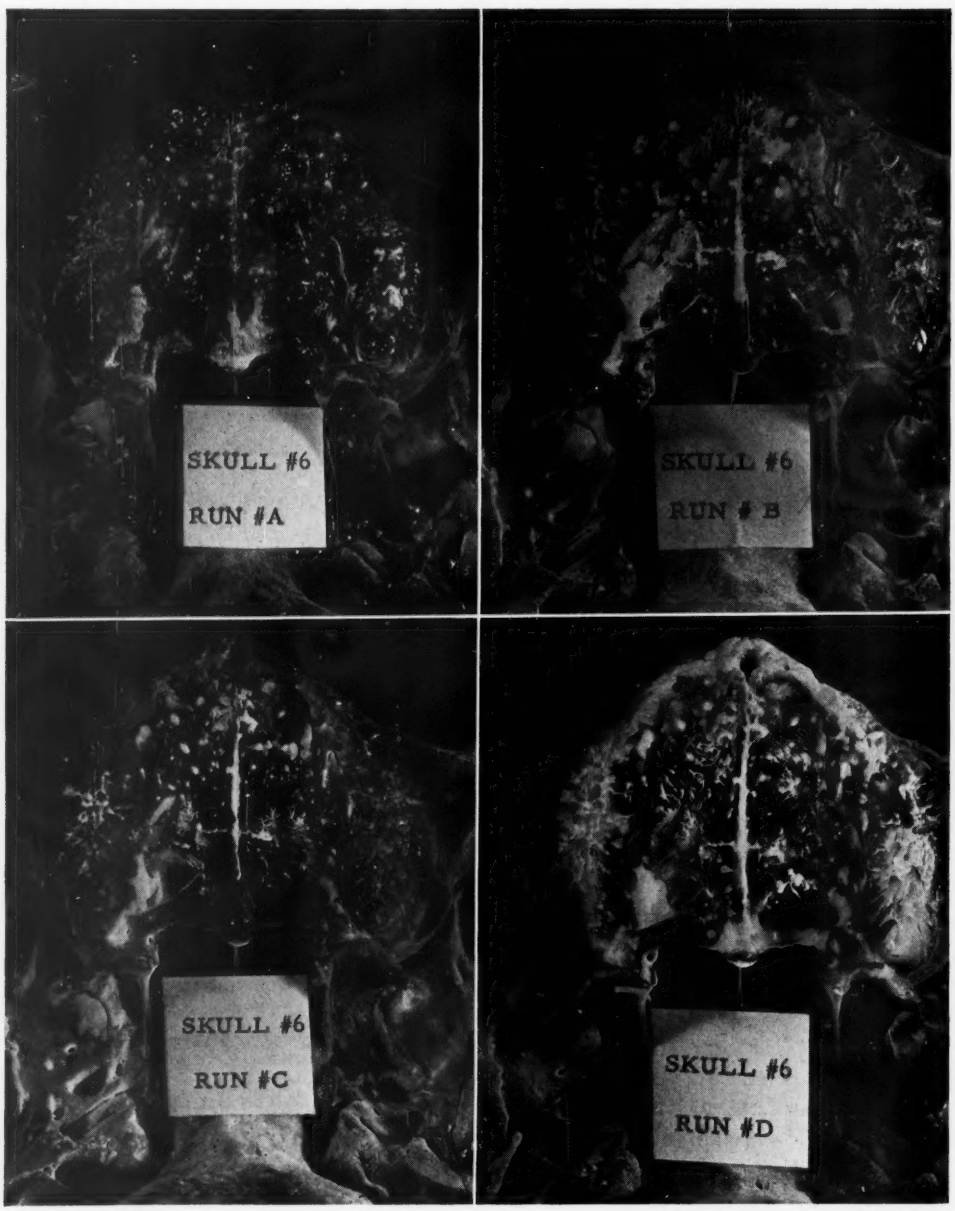

Fig. 3.—*A*, Photograph of the palate to show absence of drying cracks. *B*, Several small stress cracks have resulted from manipulative procedures. *C*, Stress patterns resulting from the testing session using flat plane dentures. Note the patterns appearing on zygomatic process on the left. *D*, Stress patterns resulting from the testing session using 30 degree inclined planes. Comparison with *C* shows more stress areas appearing anteriorly in the palate and laterally on the zygomatic process on the right.

Fig. 4.—*A*, Photograph of the mandible to show the absence of drying cracks. *B*, Stress patterns resulting from the manipulative procedures. Note the cracks on the ascending ramus on the right. *C*, Stress patterns after testing with the flat plane dentures. *D*, Stress patterns after testing with the 30 degree inclined plane dentures. Comparison with *C* shows the great increase in stress areas resulting from the inclines.

2. The strain patterns appeared out on the zygomatic process, nasal bones, the palatal portion of the maxillae, and the palatine bones (Fig. 3,*D*).

3. The patterns on the mandible were found on the body proper, and on the ramus in the area of the coronoid and condyloid processes (Fig. 4).

4. Foramena appear to be a point of weakness in so far as many strain patterns seem to originate in these areas (See Fig. 3,*C* and *D*).

5. Heavier bone structure seems to present less strain reaction per unit of force than lighter bone structure.

6. A 30 degree incline of the occlusal surfaces produces a significant increase in the strain pattern over that with the 0 degree inclined occlusal form.

DISCUSSION

These preliminary observations do not support the concept that inclined planes produce no more torque forces on the bone structure than flat planes. They rather suggest that we re-evaluate our opinions of the values of anatomic tooth forms. We should, however, be cognizant of the fact that possible advantages inherent in flat plane teeth may be lost by the utilization of balancing mechanisms.

These latter (such as balancing ramps and occlusal curves) may introduce the inclined planes that we seek to avoid by the use of nonanatomic tooth forms.

These inclines introduce occlusal forces that accentuate bone deformation patterns.

It is possible that continuing observations will reveal that artificial teeth set perfectly flat, without any balancing mechanisms whatsoever, may be of considerable benefit in combating early excessive ridge resorption.

SUMMARY

The techniques used to study bone stress patterns in other skeletal parts have been adapted to the mandible and maxillae. Preliminary observations simulating masticatory forces and function reveal that stresses resulting from dentures may be noted over a rather wide area. Heavier bone structure is less likely to produce deformation patterns per unit of force than light, weaker bone.

Initial comparisons between dentures made with 0 degree and 30 degree occlusal inclines suggest that the latter produces more stress on the underlying bone.

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A PHILOSOPHY OF PARTIAL DENTURE DESIGN

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ANY CONSIDERATION OF THE logical design of a partial denture necessitates that, first of all, we must establish the basic requirements of such a restoration. The objectives we should obtain in a partial denture prosthesis are support, stability, retention, function, and esthetics. The order of importance of these objectives may vary. Many may agree that function should be the primary consideration. Perhaps that is true and the other factors mentioned are secondary.

The partial loss of natural teeth impairs mastication, requiring the digestive organs to be overworked. This may result in impaired digestion, systemic disturbances, and general ill-health. This then emphasizes the need for replacement of the partial loss of the natural teeth, to restore function.

Any restoration, however great its ability to function during mastication, cannot do so effectively if the appliance induces discomfort. Thus, the design of our restoration should be such as to result in comfort to the teeth, their associated parts, and the mucosa at all times. The problem is to restore the function of the masticatory apparatus and to maintain it in comfort to the patient.

The knowledge that we have of tissues supporting the restoration has increased over the past several years, and we have learned to evaluate their biologic aspects and to combine that knowledge with engineering principles. Thus, we are able to construct restorations that may be worn with comfort. We could arrive at some basic design that would fit the pattern of all partially edentulous mouths if the problems were not so involved. When there is a partial loss of teeth, the equilibrium of the entire masticatory apparatus is disturbed. This loss affects the remaining teeth in that they may drift bodily, lose proximal contacts, and allow food impactions from which caries and periodontal disease may result. These remaining teeth may tip from their normal axial planes, extrude from normal alignment, or exfoliate from the alveolus because of the disturbed equilibrium. Therefore, they are subjected to undue stress and undue wear. Not only does the partial loss of teeth affect the remaining teeth, but the associated parts may change adversely in contour. The muscles of mastication may lose their tonus, may atrophy and suffer loss of traction power. Nervous habits may be induced by poor esthetics or function; in turn digestion, speech, and facial expression may be affected.

DIAGNOSIS

An accurate diagnosis arrived at from roentgenographs, articulated study casts, history, and digital and visual examination of the oral tissues is a prerequisite to

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adequate design. The diagnosis should be the basis for a complete plan for treatment. This includes judicious surgery, restoration of individual teeth, shaping of the occlusal plane, recontouring of abutment teeth as well as replacement of the teeth that are lost. The total plan, therefore, should be complete before any replacement of the lost teeth is attempted.

DENTURE BASES

What might be considered a logical sequence for the design of the components, which when combined, form the partial denture restoration? First, let us consider the spaces that are to be restored by denture teeth with resultant mechanical stability, function, occlusion, and comfort to our patient. These denture teeth are embeded in denture base material. Denture bases function in many different ways. They assist in carrying the masticatory load; they may also be designed to minimize lateral and rotary movements of the restoration. The denture bases should be designed to prevent food impaction, to provide physiologic stimulation to the underlying mucosa,[1] and in some instances to afford indirect retention. Extension denture bases should be of a size limited only by the attachments of movable tissue.

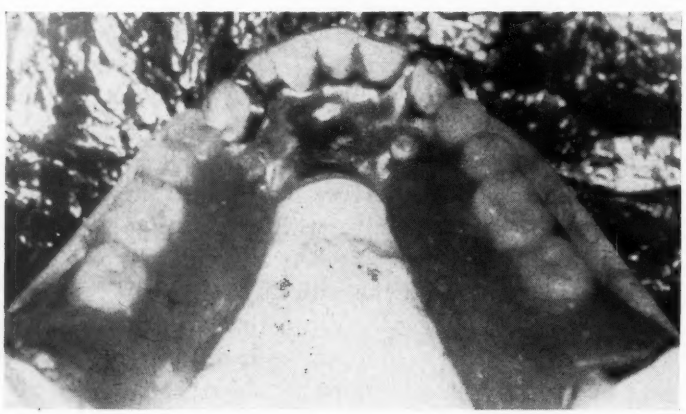

Fig. 1.—Making use of larger denture bases because of inadequate stoppage afforded by rests.

They should simulate the contour of the lost tissue and should end in natural depressions. Their size is, to a degree, affected by the location and amount of the resilient tissue, the amount of the masticatory load, which in turn is influenced by the number and kind of teeth that are lost, the development of the patient's musculature, the age and health of the patient. The size is also influenced by whether the opposing teeth are cusped or flat, as well as by their size, regardless of whether or not the opposing teeth are natural or are tooth- or tissue-borne replacements. When part of the masticatory load is carried by occlusal rests, the size of the denture base may be reduced, frail occlusal rests require larger denture bases (Fig. 1), adequate occlusal rests allow a reduction in size of the denture base. Weakened abutment teeth should be protected by larger denture bases. The type and condition of the tissues underlying the denture base affect its size since flabby tissue indicates the need for greater tissue coverage as does also thin, inelastic tissue. Spinous bony process and rough bone contours require larger bases.

A few general rules for the design of denture bases are: (1) Large bases are generally safer. (2) To prevent food impactions and be less noticeable to the patient's tongue, the margins of the denture bases should end in natural depressions on resilient tissue. (3) The free gum margins of adjacent teeth should not be approached closer than one-sixteenth of an inch in order to minimize impingement upon the gingivae. (4) In the choice of the material for denture bases, provision for refitting should be considered.

MAJOR CONNECTORS

However adequate partial denture bases are, they cannot function independently. The major connector is necessary to join the denture bases and aid in their stability. Major connectors along with the retainers are the components which answer the requirement of stability. To stabilize the teeth that support the restoration as well as the restoration itself, major connectors should exhibit rigidity in function. To have the connector exhibit rigidity, it does not need to be of large cross-sectional bulk if its contour is such as to make it rigid. In the maxillary

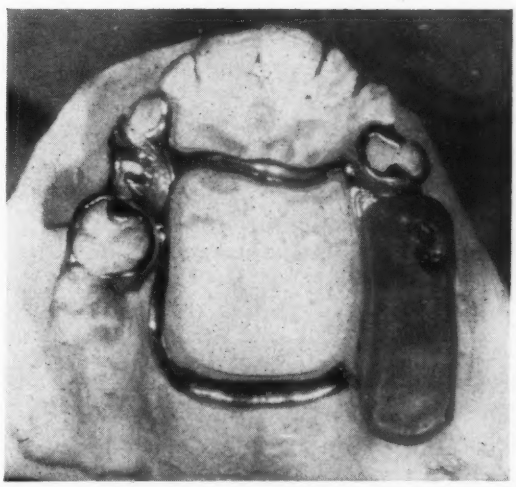

Fig. 2.—Demonstrating the principle of the solid ring and the location of the anterior major connector in the furrows of the rugae.

arch, a relatively small, cross-sectional bulk of anterior and posterior connectors will, with their bases, have the effect of a solid ring. This effect is much more rigid than a single connector traversing the palate, even though this single connector may be larger in cross section than the combined anterior and posterior bars of smaller cross section. The anterior bar crossing the palate in the furrows acts as a series of "angle irons" which are designed to give the greatest rigidity per unit of material. It can be small and, in its position over the rugae, hardly noticeable to the tongue of the patient (Fig. 2). The posterior bar can be constructed with its greater bulk toward the soft palate, thinner toward the anterior to diminish the amount of material used and to give relatively greater patient comfort. It should cross the palate in the region just anterior to movable tissue, sweeping forward at the sides to join the saddles (Fig. 3).

The major connector for a lower denture must be a single span of metal, and its size must, of course, be relatively greater to minimize torsion. Here again, however, the angle iron principle can be used to give rigidity in function. Variations of the mandibular connector may be used to diminish its size in any one area, such as distributing a thin weblike casting over the anterior teeth. This web may serve two purposes: (1) to minimize the cross-sectional bulk of metal and maintain adequate rigidity, and (2) to stabilize weakened lower anterior teeth by splinting them together. The torque that might otherwise be transferred to any one tooth is distributed diminishingly to all of the teeth.

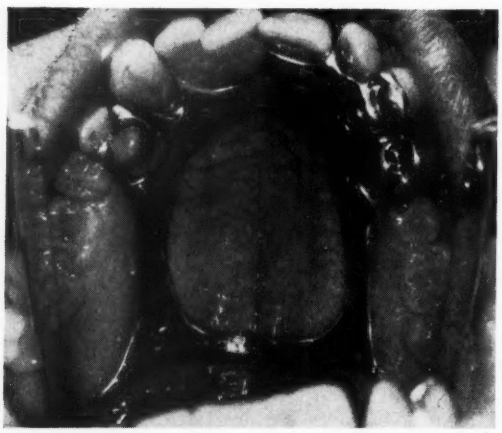

Fig. 3.—Showing the placement of the posterior major connector in relation to the tissues of the mouth, as well as the position of the anterior connector when lost anterior teeth are to be replaced.

OCCLUSAL RESTS

In any consideration of the partial denture, we discover that two structures oppose the occlusal load. One is the soft tissue foundation underlayed by bone upon which the base of the denture rests. The second is the abutment tooth or teeth. Of the two, the latter is more capable of resisting applied stresses. Bases and rests are the components of support in partial denture design, and the component which permits the transfer of all or part of the masticatory load to the abutment teeth is the occlusal or incisal rest.[2]

To fully understand the proper preparation of the tooth to receive the occlusal rest, one must appreciate the functions of that portion of the denture.

In addition to the resistance offered by the occlusal rest against the masticatory load, and the prevention of the denture from seating past the intended position, we find that the rest also gives lateral stability to the appliance. This bracing reduces undue lateral stress against the soft tissue of the ridges.

One of the important functions of the occlusal rest is the deflection of food away from the area of contact of the denture with the abutment teeth. When properly designed, the rest deflects food bucally and lingually rather than allowing it to wedge between the clasp attachment and the abutment tooth where it may become a potential cause of trouble.

This important part of the partial denture is useful also where tipping or rotation of the abutment tooth has impaired functional occlusion. By increasing the size of the rest, and by altering its occlusal surface, the occlusion may be greatly improved.

Indirect retention of the restoration may be secured by the use of auxiliary occlusal rests. For example, we might have a second bicuspid serving as the abutment for a distal extension partial denture and, desiring greater retention and stability, we would use an occlusal rest on the mesial side of the occlusal surface of the first bicuspid. This second or auxiliary rest on the first bicuspid assists in holding the denture base firmly to the ridge tissue, against either the forces of gravity or the pull of muscular tissue against the borders of the denture.

One of the most important functions of the rest is to maintain proper clasp-to-tooth relationship. Without the occlusal rest, the denture and clasp may be driven toward the gingival tissue with two serious results: (1) The clasp and denture may impinge upon the tissues that afford support and attachment for the abutment tooth, and by causing injury to those tissues, destroy the value of the abutment tooth itself. (2) Since clasp retention is in the infrabulge of the tooth, any movement toward the gingival portion of the tooth brings the clasp into an area of lesser tooth circumference. This results in a loss of the effective retention which the clasp was designed to provide.

From these important functions of the occlusal rest, it would seem obvious that two classes of partial restorations must embody its use. These are the fully tooth-borne partial denture, and the composite or partial denture which is both tooth and denture base supported. It is also apparent that to fulfill all of these functions certain care must be employed in design and construction of the rest.

PREPARATION OF TEETH FOR OCCLUSAL RESTS

In preparing a tooth for occlusal rests, the dentist must adhere to certain principles. One very important rule is that the preparation should seldom, if ever, be allowed to penetrate past the dentoenamel junction. As a general rule, if such penetration is necessary or occurs, the abutment tooth should be protected by the insertion of a gold inlay. The rest may be placed on the surface of this inlay with confidence that dental caries will not result from such contact. Deep fissures in the enamel should be obliterated, if necessary, by resorting to filling materials. Application of silver nitrate to the prepared rest area is another preventive measure that may be used against future decay under the occlusal rest.

A second important principle is that the seat or floor of the rest preparation should be at right angles to the long axis of the tooth. This holds true even for abutment teeth that are tipped from their normal position. By employing this rule, the occluding forces against the restoration are directed against the abutments in a line with the long axis of the tooth. The very nature of the periodontal membrane is such that the tooth is best able to withstand forces in this direction. Lateral or torsional forces are far more destructive to the stability of the tooth.

The preparation for the occlusal rest seat should be definite in nature, but not box-shaped. Ideally, it more nearly represents the form of a shallow bowl or spoon.

Such a preparation allows for adequate slippage of the denture with a minimum of lateral force or torque on the tooth. Food impaction is likewise less troublesome in such a preparation as compared to the box type of rest seat.

Adequate buccolingual width of the rest is important if proper food deflection and added strength is to be gained. In general, this width should be approximately one-half the distance between the distolingual and distobuccal angles of the abutment tooth, assuming that the clasp is to be on the distal side of the tooth.

The occlusal rest must be of sufficient thickness to withstand breakage (Fig. 4), and, while this point is covered to some degree by the depth of rest preparation in the abutment tooth, further care is needed. Study casts should be checked carefully to determine the possible strength of the proposed rest and, if necessary, (to prevent too deep a penetration of the enamel) the opposing tooth may be relieved suitably. This study of the occlusion by means of casts will also reveal what improvements may be made in the occlusion by building the rest up to contact the opposing tooth or teeth more adequately.

Fig. 4.—To illustrate rests of an adequate thickness to prevent fracture and of adequate buccal lingual width to allow for the deflection of food.

A final principle to follow is the removal of all sharp angles in the rest preparation. This is particularly important in respect to the proximal marginal ridge area. If left sharp and angular, a similar sharp angle will be created on the tooth side of the rest, resulting in a potential weakness that may lead to fracture of the rest. Giving this tooth angle a bevel will also allow for a greater bulk of metal in the rest at this vulnerable point.

The preparation of a tooth to receive an occlusal rest should follow a definite routine or technique. A suggested procedure is first to carry the preparation to the desired depth in the enamel by the use of a sharp knife-edge or diamond stone. Then with a round-edge stone, of a size suitable to the tooth, give the preparation the spoon-shape form we desire. Round stones are useful for this purpose also and may, in some cases, be better used in the contra- or right-angle handpiece. All sharp angles are now removed with sandpaper disks. These disks, placed on the mandrel in pairs, back to back, are also of great value in smoothing the preparation. The dentist should work from medium grits to fine, and, finally, completely polish the prepared tooth surfaces with some medium such as pumice and whiting. Rubber

polishing disks are of value in this work. When carefully polished, such a prepared enamel surface should compare favorably with the sheen of natural enamel and present considerable resistance to caries.

DIRECT RETENTION

The purpose of direct retention is stabilization which is twofold. The teeth carrying the increased load of the partial denture must be stabilized as well as the restoration itself. This stabilization of teeth is most important and can be secured in different ways, not the least important of which is the transfer of the load to as many abutment teeth as is possible (Figs. 5 and 6). Two abutments should not support the entire masticatory load when four may be available.[3] The so-called internal attachment gains its stabilization by having the torque within the tooth itself. Also, this attachment utilizes contacting parallel precision parts which make use of friction to fix the restoration.

Fig. 5

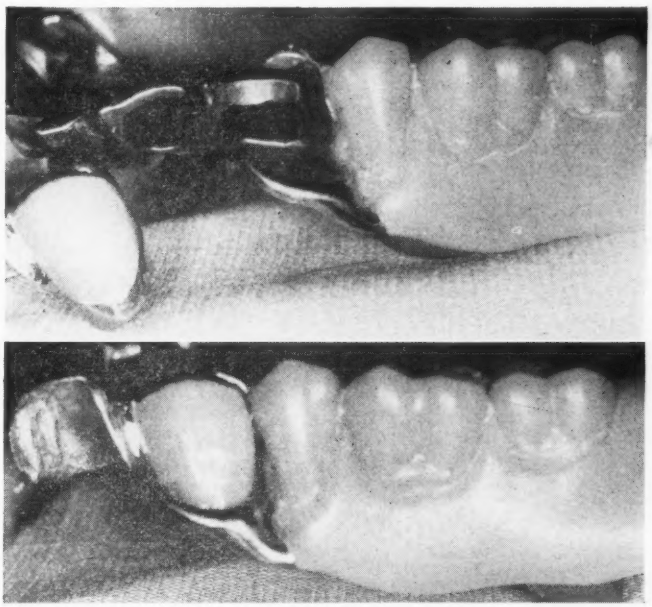

Fig. 6.

Fig. 5.—The individual tooth restorations are removed in order that the supporting elements of the prosthesis can be viewed. These elements support the denture against vertical and lateral thrusts.

Fig. 6.—The same prosthesis as in Fig. 5. Note the relation of the individual tooth retainers to the prosthesis and the splinting of the abutments to transfer the load diminishingly to both abutments.

That design of the external attachments which gains its retentiveness from an approach below the infrabulge is relatively more retentive than the suprabulge clasp (Fig. 7). Clasp arms that are quite resilient are perhaps the most commonly used. This clasp design presents a force against the tooth upon insertion and removal that must be stabilized by a reciprocal passive force on the tooth area opposite this retentive arm.

Of course, horizontal forces against the teeth and tissues supporting the denture bases are also reciprocated to some extent by clasp action on the opposite side of the arch. There are many variables that have to do with the degree of retentiveness that a clasp will exhibit.[4] One of these is the depth of the undercut below the height of contour. Recent developments in the survey of casts enable us to measure this depth of undercut; thus we can balance the retention on the abutment teeth.

INDIRECT RETENTION

The bilateral extension denture base partial denture is perhaps the most common. It may well be the most dangerous to the abutment teeth, usually two in number, unless the denture is stabilized by equalizing the forces on either side of the fulcrum line. This is done by the *indirect* retainer (Fig. 8), occlusal rest, anterior web, Kennedy bar, and by maintaining the area under the denture bases in physiologic function. Clasps function better in stabilizing lateral forces when the occlusal rests are not attached positively to the retentive element of the retainer.

Fig. 7.

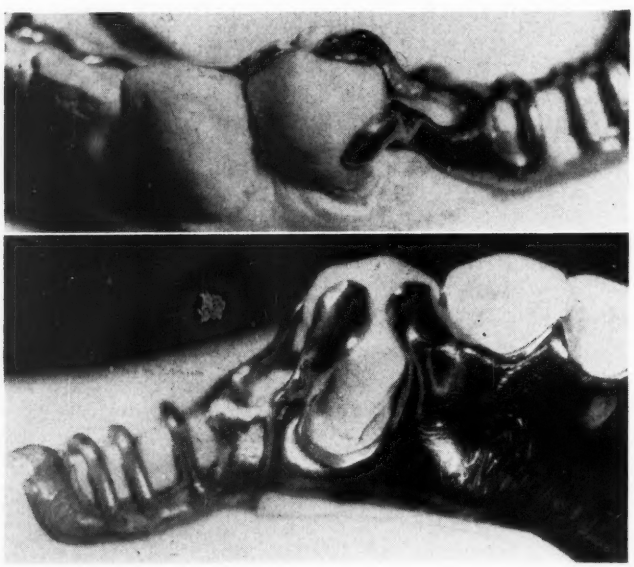

Fig. 8.

Fig. 7.—A modified infrabulge retainer that maintains the prosthesis passively in function. The rest seats are designed to allow for adequate reciprocation of the retentive clasp action. Note the manner in which the retentive element is attached to the supporting element of the retainer.

Fig. 8.—The lingual portion of a prosthesis demonstrating the use of the web as an indirect retainer as well as a splint to support the anterior teeth against the lingual force of the incisive bite.

Prothero[5] described an imaginary line connecting the occlusal rests which he called the fulcrum line, about which and upon which the restoration tends to rotate. Resistance to this rotation is called *indirect retention,* and the component in our design is called the *indirect retainer.* Indirect retention is defined by Applegate[6] as

being across the fulcrum line and away from the part of the restoration being retained, and it operates by employing the law of the lever. The further the indirect retainer can be placed from the fulcrum line, the less the resistance required to stabilize the restoration against rotation. However, in dentures of Kennedy's No. 1 classification, if the indirect retainer is placed as far from the fulcrum line as possible, it would rest on incline planes where its force would be exerted lateral to the long axis of the tooth or teeth upon which it rests. This would present an unfavorable torque on the tooth as well as a less positive resistance to movement. A better location for the indirect retainer is on a tooth on which the force may be directed along the long axis of that tooth, such as an occlusal rest in the mesial pit of a first bicuspid. The effectiveness lost by shortening the lever arm is regained by the use of a more suitable tooth surface. When anterior teeth have been weakened by undue stresses because of the loss of posterior teeth, or by periodontal involvement, a web which acts as a splint may be used advantageously. This web may be continued forward from rests on the bicuspids. It is continuous with the major connector, overlying but not contacting the free gingival tissue. In the event of the loss of anterior teeth, the denture bases may be used to afford indirect retention.

GOOD ESTHETICS ENHANCE MENTAL COMFORT

Esthetics are improved by the use of partial dentures which are retained by internal attachments. When external attachments are used, preparation of the mouth to permit the retainer to clasp the tooth toward the gingival margin not only improves the esthetics but reduces leverage on the abutment tooth. Drifted and tipped teeth may be reduced and aligned to allow for a more pleasing appearance of the replaced teeth, and a better approximation of the appliance to the remaining teeth. Clasps in the anterior portion of the mouth are more esthetic when confined to the embrasure area adjacent to the restoration. There is less embarrassment on the part of the patient when anterior teeth are to be lost if the immediate insertion partial denture is used.

CONCLUSION

There are a few basic requirements in partial denture design that must be met if the restoration is to function adequately and with comfort.

1. *Support.*—This is achieved by the use of adequate denture bases and occlusal rests.

2. *Stability.*—This is necessary not only for the restoration but also for the teeth themselves. Connectors as well as retainers stabilize the restoration and the abutments against lateral stresses.

3. *Retention.*—Retainers, both direct and indirect, resist the forces of dislodgment and rotation of the restoration.

4. *Esthetics.*—Judicious shaping of tipped or drifted teeth by stones allows for the more harmonious restoration of missing teeth. The immediate insertion partial denture provides mental comfort to the patient.

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LATERAL FORCE IN RELATION TO THE DENTURE BASE AND CLASP DESIGN

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THE CHEWING CYCLE HAS force components that can be broken up into lateral, occlusal, and vertical displacement forces.[1] The purpose of this article is to analyze lateral force transmission in relation to denture base location and clasp design. Since a mathematical approach to this problem is impractical, an experimental model was constructed to simulate the type of tooth movement found in the mouth. Partial dentures of various designs were constructed and tested on the model to see if the torques and rotational patterns discussed in the text took place as described.

The basic mechanical factors in this article were formulated in consultation with a mechanical engineer.*

LATERAL FORCE

Lateral force on a partial denture framework initiates two component torques; one is a vertical rotation which is perpendicular to the occlusal plane, and the other is a horizontal rotation parallel to the plane of occlusion. The distribution of these forces to the supporting structures depends on many factors such as: (1) the saddle location, (2) the type of connecting bar, (3) clasp design and fit, (4) mobility of the teeth, (5) the resiliency of the metal framework itself, (6) the root shape and size of the abutments, and (7) the alveolar height.

THE VERTICAL ROTATIONAL COMPONENT

Physical Data.—Simple physical data related to the vertical component of lateral force transmission should be examined to understand better the lateral forces as they are in the mouth. The factor of a periodontal membrane will be discussed when these principles are applied to clasp forces. If a rigid object, designed as in Fig. 1, were imbedded in a hard base, a lateral force applied at point *A* on one side would be distributed to the bases of both sides *B* and *C* with no tipping action.

If the uprights were not connected rigidly to the bar and buried in a yielding base similar to dirt, then a lateral force at *A* would cause a change in angulation between the uprights and the connecting bar *D* and *E* (Fig. 2). This change in angulation permits a tipping action on each upright. If we combine the above and make the uprights and bar rigid but the base compressible, the picture changes (Fig. 3). With the angles at *D* and *E* unchanged, application of lateral force at

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A would cause the object to rotate in an arc. In a rigid body there can be only one center of rotation. The exact location of this center of rotation depends on the shape of the upright and the resistance of the base as the frame moves.

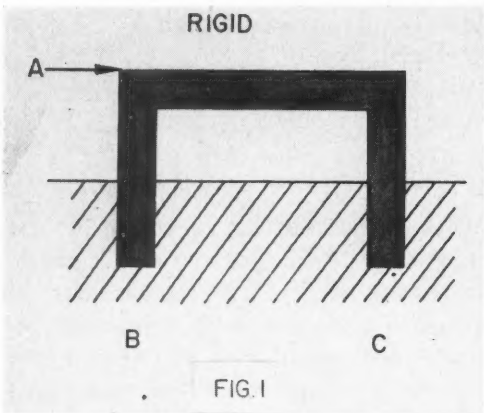


FIG. 1

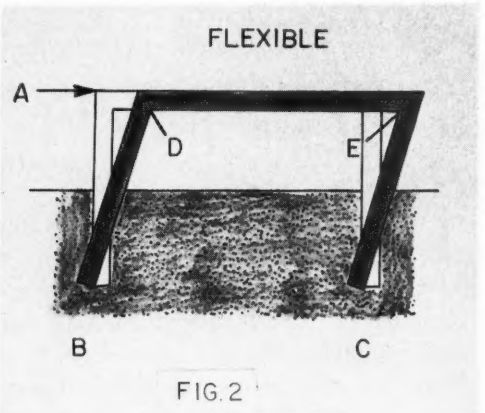
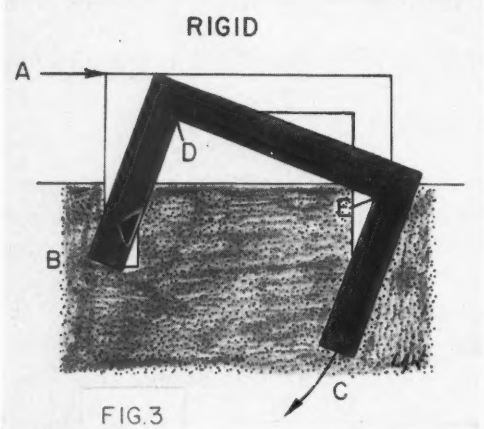


FIG. 2



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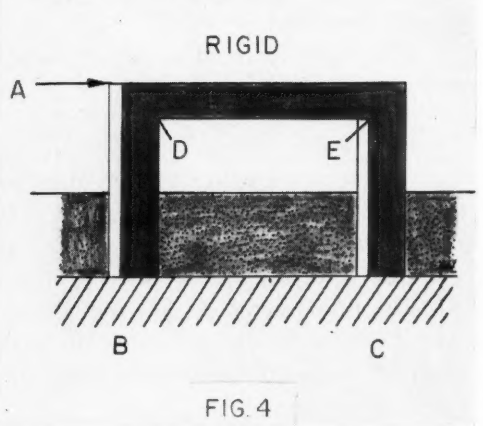

FIG. 4

Fig. 1.—A rigid frame imbedded in a hard base; lateral force *A* is shared by both bases *B* and *C*.

Fig. 2.—A nonrigid frame imbedded in a yielding base; lateral force *A* causes a tipping action on each upright due to change in angulation at *D* and *E*.

Fig. 3.—A rigid frame imbedded in a yielding base; lateral force *A* causes a rotation about the center of rotation.

Fig. 4.—A rigid frame imbedded in a yielding base; this placed on a solid base; lateral force *A* causes horizontal displacement.

If we modify the conditions of having a rigid body and a compressible base (Fig. 4) by placing the whole system on top of a concrete noncompressible base, then changes in force transmission take place. A lateral force at *A* would cause the whole structure to move bodily in a lateral displacement through the movable earth. Rigidity prevents a change in angulation of the rigid uprights to the bar at *D* and *E* and the noncompressible concrete prevents rotation. (In all cases removal of the uprights from the supporting structure was prevented.)

In the mouth, we do not have such simple geometric systems, but if we can discuss what force patterns result with a given set of conditions, we can rationally see the advantages of one type of design over another as approaching the ideal within practical limits.

Flexible Lingual or Palatal Bar.—If a lateral force is applied at point A_1 (Fig. 5) and the bar can flex at point B_1, a tipping force can be exerted on the

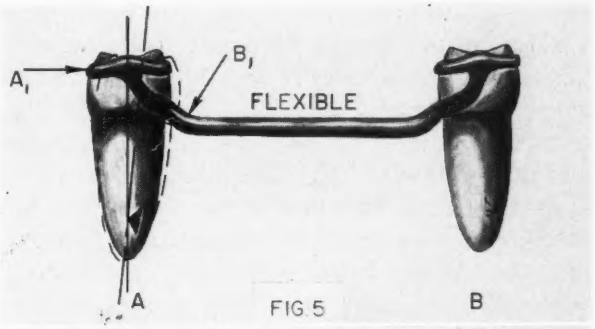

FIG. 5

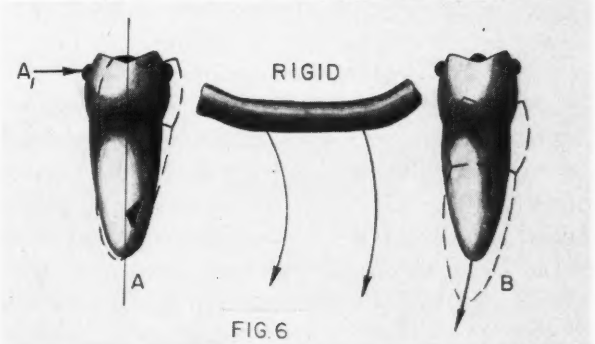

FIG. 6

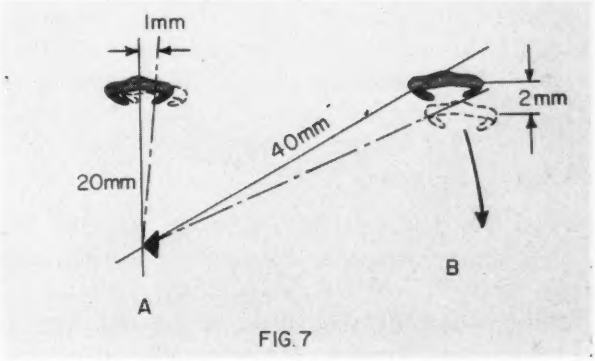

FIG. 7

Fig. 5.—A flexible lingual bar; lateral force A_1 causes a tipping action on the abutment A due to flexing B_1 of the bar. The opposite side B does not share much of the stress.

Fig. 6.—When a rigid lingual bar and clasping are used, lateral force A_1 initiates a vertical rotational component about the center of rotation on that side.

Fig. 7.—A tipping movement of 1.0 mm. on abutment A with geometric distances as shown would require depression of the clasp on the opposite side B of 2.0 mm. The resistance to depression on the opposite side helps limit the tilting action on the side of the lateral force application.

tooth of side *A*. The opposite abutment *B* will have a lesser force exerted on it. The more flexible the bar, the less the distribution of force to the opposite abutment.

Rigid Lingual or Palatal Bar.—If the bar is rigid and the clasps have rigid buccal and lingual components, then the only way to have a tipping force exerted on tooth *A* (Fig. 6) from a lateral force at point A_1 is to have the whole unit revolve about the center of rotation located near the apical third of the tooth. (According to engineering information, the pin-point location of the fulcrum would depend on the root shape, the resistance of the periodontal membrane, and the alveolar height; we can say that it is in the area of the apical third of the root.) This rotation is similar to the conditions in Fig. 3 where the base is compressible.

For the purposes of illustration, only clasps are shown in Fig. 7. If we had a tipping movement of 1.0 mm. of the abutment *A*, then by simple geometry we could calculate how much depression we would have to have on the opposite side. Here, arbitrarily, we have made the distances from the clasp to the fulcrum on tooth *A* 20 mm. and the distance between the abutments on the opposite side 40 mm. With these distances, the clasps on side *B* would have to be depressed 2 mm.

What conclusion does this analysis indicate as applied to the mouth, with the complicating factor of the periodontal membrane and minute movements? In order to get a tipping action of a certain magnitude with the above geometrical distances, we would have to depress the opposite abutment in its socket twice as much. Since the teeth resist depression in their sockets much more readily than tipping action, then the side opposite the application of the lateral force tends to resist the tipping action of the abutment on the side of the original lateral force.

With present metallurgic knowledge, completely rigid lingual or palatal bars cannot be constructed. Due to the resiliency of the metal bar, complete elimination of lateral tipping cannot be obtained. However, the more rigid we design the partial denture, the less the lateral tipping force will be to the abutments.

In summary, some of the factors that resist tipping forces on the abutment teeth on the side of lateral force application are: (1) the resistance to compression on the opposite side; (2) the degree of rigidity of the bar; (3) the rigidity between the tooth and the clasp. The mechanical efficiency of the system obviously depends on the location and distance between opposing abutments.

LATERAL FORCE TRANSMISSION WITH VARIOUS CLASP DESIGNS

Rigid Buccal and Nonrigid Lingual Clasps.—If a lateral force is applied at A_1 (Fig. 8), the lingual clasp can flex, allowing a change in angulation between the tooth and framework. When this occurs, a tipping force is applied to that abutment and a lateral force is distributed to the opposite side through the rigid lingual bar, instead of a vertical rotation. This resembles the physical data indicated in Fig. 2.

When the lingual clasp on the side opposite the lateral force application is very flexible, then that abutment would not share much of the load (Fig. 8); the relative rigidity of the lingual clasp determines the quantity of stress to that abutment.

Rigid Buccal and Lingual Clasps.—If the buccal and lingual clasps are rigid (Fig. 9), then the lateral forces, for the most part, will be transmitted to the bone

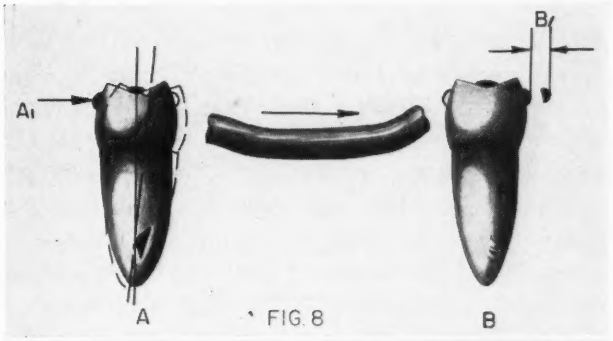

FIG. 8

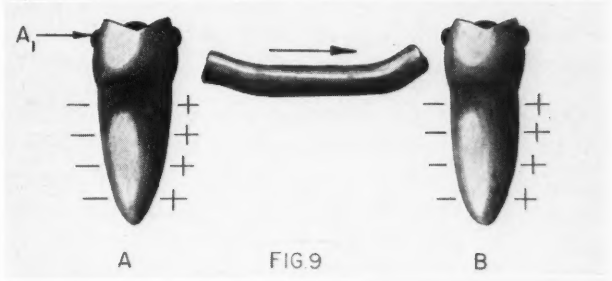

FIG. 9

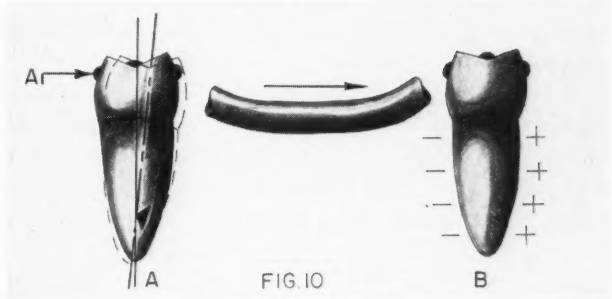

FIG. 10

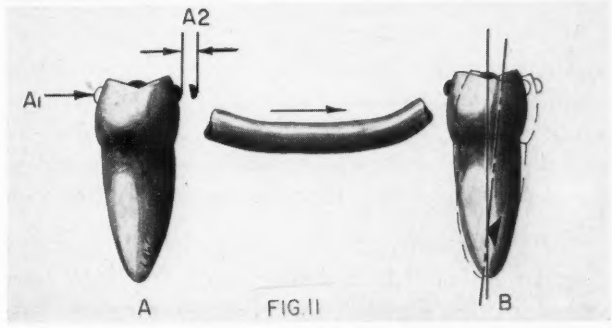

FIG. 11

Fig. 8.—Rigid buccal and nonrigid lingual clasps; lateral force A_1 causes a tipping of abutment *A* due to the change in angulation between the tooth and framework permitted by the flexible lingual clasp. The opposite side *B* does not share much of the stress.

Fig. 9.—Rigid buccal and lingual clasps; lateral force A_1 results in mostly horizontal pressure due to the rigid framework and lack of compressibility of the opposite abutment *B*. This resembles Fig. 4.

Fig. 10.—Rigid clasping and framework with poor buccal fit on abutment *A*. Due to the change in angulation between the tooth and framework, lateral force at A_1 causes tipping of abutment *A* with mostly horizontal distribution to abutment *B*.

Fig. 11.—Rigid lingual and flexible buccal clasps; lateral force A_1 can cause a flexing of clasp A_2 with most of the force distributed to the opposite side *B* in a tipping action.

in a horizontal manner by the rigid lingual bar. There will be compression of the periodontal membrane on one side of the roots and tension on the other. This resembles the system given in Fig. 4, since the resistance to compression of the opposite abutment inhibits the tipping action on the side of the lateral force application; most of the force is distributed horizontally through bone.

One might ask why would the abutment on the opposite side to the application of lateral force transmit a horizontal force rather than tilt *B* (Fig. 9)? The rigid buccal and lingual clasps can prevent a change in angulation between the partial denture framework and the abutment tooth, which is a prime requisite for the tilting action. If the rigid segments of this clasp fit accurately, slippage should not occur due to the frictional resistance between the tooth and the gold. The more the buccal and lingual surfaces of the tooth approach the vertical, the less chance that slippage can occur.

Variable Factors.—It would seem that the distribution of lateral force to the supporting structures in a horizontal manner as seen in Fig. 9 would be the most desirable. However, this is based on rigid lingual bars with accurately fitting rigid clasp components. What would happen in the above situation if the buccal clasp A_1 (Fig. 10) did not fit accurately, and slippage could occur? A lateral force at that point initiates a tipping action on abutment *A*. The lateral force transmitted in the rigid lingual bar, for the most part, will be distributed to the bone of the opposite abutment *B* in a horizontal manner with compression on one side of the root and tension on the other. The rigid clasping on this side prevents a change in angulation between the framework and tooth. A poor fit of a clasp on any abutment usually results in a tipping action on that abutment and a change in the lateral force distribution both in type and magnitude. It should be restated here that the resiliency of the metal will allow a slight degree of tipping even with rigid clasping, and we hope that it is clear that, with present metals, complete elimination of the tilting action on the abutments cannot be accomplished.

Rigid Lingual and Flexible Buccal Clasp Elements.—In the case where we have a rigid clasp element on the lingual and a flexible one on the buccal (Fig. 11), the lateral force applied to the clasp at A_1 causes a flexing A_2 with more of the stress being transmitted to the other side. The flexible buccal clasp on the opposite abutment *B* allows a tipping action due to the change in angulation between the tooth and framework; this resembles the situation in Fig. 2 at point *E*.

Precision Attachments.—Precision attachments can transmit lateral forces in a horizontal manner rather than a tipping force simply by having the occlusal portion of the attachment *A* (Fig. 12) as well as the gingival portion *B* move the same distance from the original position. If the lingual bar is not rigid and can flex at A_2 (Fig. 13), the occlusal portion of the attachment can move a greater distance from the original position than the gingival portion, causing a harmful tipping action. The same condition can occur on the opposite side *B* due to the flexing of the lingual bar at B_1. Even though the type of attachment is the most desirable from the standpoint of lateral force transmission, the advantage is lost by a nonrigid lingual bar.

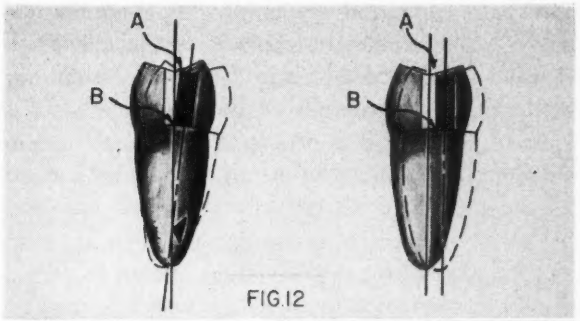

FIG.12

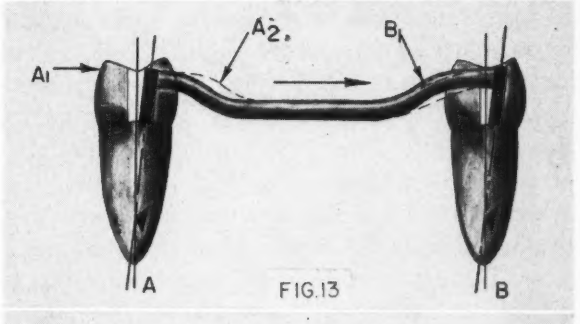

FIG.13

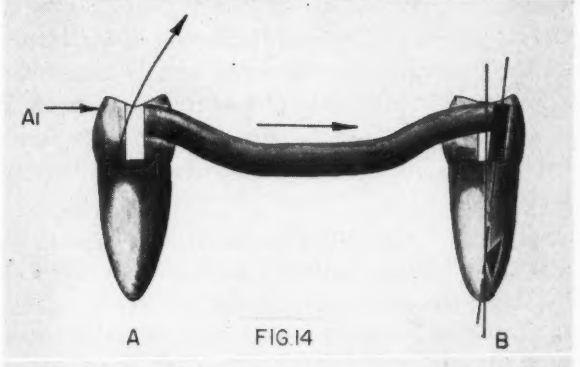

FIG.14

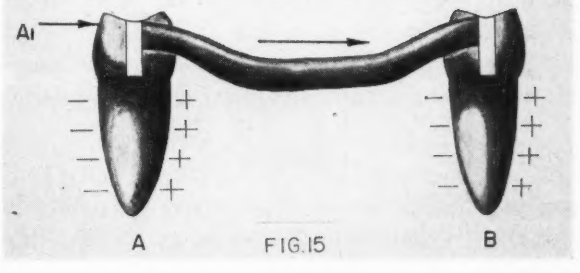

FIG.15

Fig. 12.—A precision attachment causes tipping when the occlusal portion *A* moves a greater distance from the original position than the gingival portion *B*. Horizontal pressure is exerted on the supporting structures when *A* and *B* move the same distance from the original position.

Fig. 13.—Precision attachment with a flexible lingual bar; lateral force A_1 can cause a tipping action to each abutment due to flexing at A_2 and B_1.

Fig. 14.—Rigid lingual bar and precision attachments; tipping of abutment *B* due to lateral force A_1 can only occur if attachment follows the arc of rotation of abutment *B*. Attachment in abutment *A* and occlusal component of force prevents this rotation.

Fig. 15.—Precision attachments with rigid lingual bar; lateral force A_1 initiates mostly horizontal displacement rather than tipping because rigidity prevents change in angulation between the tooth and framework.

If a rigid lingual bar is used and lateral force A_1 is applied (Fig. 14), the only way to have a strong tipping action transmitted to the opposite side B would be to have the whole partial denture rotate about the fulcrum point on the side opposite the force application. The lateral walls of the precision attachment in tooth A would resist the arc of rotation if it is constructed with maximum length. In addition, the biting force that initiates the original lateral force at A_1 has an occlusal component that would tend to resist any upward movement of the saddle.

Tipping of the tooth on the side of the lateral force application A is resisted by the lack of compressibility of the opposite side as seen in previous clasp designs. Since the vertical compression of a tooth in its socket is most efficiently resisted by the periodontal membrane, most of the lateral forces applied to abutment A will be distributed in a horizontal manner through both abutments. This will resemble the mechanical system in Fig. 4 where the concrete beneath the compressible dirt resisted the rotation of the rigid body, and, therefore, the lateral forces were distributed horizontally to the dirt supporting the uprights.

The resultant picture is shown in Fig. 15 where most of the lateral forces applied at A_1 will be transmitted to the supporting bone as a compression on one side of each root and tension on the other. It would seem logical, therefore, that a precision attachment is the most efficient and desirable method to transmit lateral forces to the supporting structures.

Summary of the Factors in Vertical Rotation.—If we have rigid buccal and nonrigid lingual clasp elements, a lateral force usually causes most of the strain distributed to the abutment on the side of force application in a tipping manner (Fig. 8). When buccal and lingual clasps of both sides have rigid segments, the lateral force will be distributed to both sides more in a horizontal manner than in a tipping action (Fig. 9).

Inaccurate fit of a rigid clasp usually causes a strong tipping action to the abutment. When flexible lingual clasps are used in such a case, most of the force would be taken by that side in a tipping action (Fig. 8). With rigid clasps on all teeth, including the above defective buccal fit, a lateral force on the side of the defect could cause a tipping on that side and a horizontal transmission of force to the supporting structures on the other side (Fig. 10). Where there are rigid lingual and flexible buccal clasp segments, lateral force distributes most of the load to the opposite side in a tipping action due to the buccal clasp flexing (Fig. 11).

CONCLUSIONS

A rigid lingual and flexible buccal (back-action clasp) would be the most inefficient method for the distribution of lateral forces to the supporting structures. The most efficient and desirable would be the rigid buccal and lingual clasp elements that tend to limit the tilting forces on the abutments. When used with rigid bars this design distributes the lateral forces more horizontally.

The ideal rigid lingual bar, the exact fit of clasps, as well as the slight compressibility of the periodontal membrane are factors which make the complete elimination of tipping action and the absolute horizontal distribution of lateral force to the supporting structures a theoretical ideal. When indicated, a precision

attachment eliminates the variables of accurate fit and slippage, and by striving for a rigid bar we can work for more favorable conditions approaching the ideal within these practical limits. Reduction of the guiding inclines in lateral eccentric movements will further diminish the amount of lateral stresses.[2-7]

THE HORIZONTAL COMPONENT OF LATERAL FORCE TRANSMISSION

Application of lateral force on a partial denture will initiate a horizontal rotation component parallel with the occlusal plane. The pattern of the rotational tendency is influenced by such factors as: (1) the saddle location, (2) the point of application of lateral force, (3) clasp design and fit, and (4) the relative rigidity of the lingual or palatal bar.

Application of lateral force at point A_1 (Fig. 16) near the posterior abutment can result in a horizontal rotation about the anterior abutment A on that side. Fig. 17 shows abutment A as the center of rotation and its tendency to rotate in the socket. Abutment B will tend to tip ligually, and abutment C will tend to tip in a mesiobuccal direction, while abutment D will tend to tip mesially.

If lateral force is applied near the anterior abutment A_2 (Fig. 18), the posterior abutment B on that side will become the center of rotation. Abutment A tends to tip lingually, abutment C in a distal direction, and abutment D in a distobuccal direction. Theoretically if the mobility of all the abutments were equal and the denture was symmetrical, lateral force applied in the middle of the saddle at point A_2 (Fig. 16) would result in mostly vertical rotation and little horizontal component. Practically speaking, however, it seems unlikely that such a balanced condition would exist, and we would expect one or the other abutments on that side to act as a center for horizontal rotation.

Rigid Buccal and Lingual Clasp Elements.—Rigid buccal and lingual clasp elements help limit the tipping action when the force is buccal or lingual in direction, as initiated by vertical rotation; but as the direction changes toward the mesial or distal, as in horizontal rotation, the fingers of those clasps can flex, and a change in angulation can exist between the tooth and the framework; this allows a tipping action. However, if internal attachments are used with a rigid framework, this change in angulation between abutment and framework is resisted. In that case, the lateral forces must "push" the whole tooth bodily against its bony support in the direction of the force.

Factors in Tooth Mobility.—Obviously the health of the periodontal membrane and alveolar bone are vital factors in tooth mobility. Even teeth with "normal" supportive tissue can differ in their resistive capacities to forces in certain directions, because they differ in root length, root curvature, and root shape.

A square-shaped root in cross section will resist rotational forces better than a round root. The round root will have tension on most of the periodontal fibers, whereas the elliptical or square-shaped root will have compression in some areas and tension in others. Even if these teeth had perfectly "normal" supportive tissues, they differ in their ability to withstand torques applied to them.

When a buccal or lingual force is expected on an abutment, its root shape and length should be considered, as well as the height of the alveolar bone and peri-

odontal health. If the framework is not rigid, the individual teeth on one side will have to withstand the lateral stress instead of distribution to the other side.

It is extremely difficult clinically to measure accurately the resistance of an abutment to rotational and lateral forces. We can only make the best clinical examination possible, testing for comparative mobility of the abutments, and use roentgenograms to help determine the strength of each abutment by its root shape, length, and alveolar height.

Partial Denture Design.—We can correlate the horizontal rotational forces with the ability of the abutments to withstand the torques applied to them, and

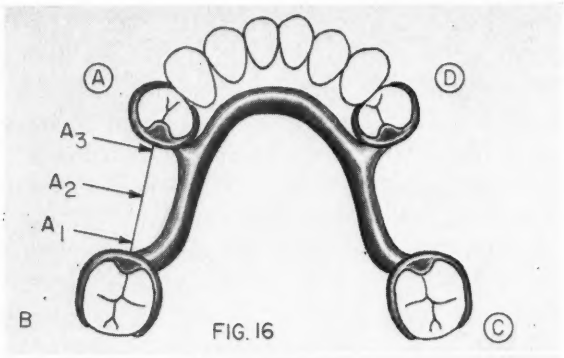

FIG. 16

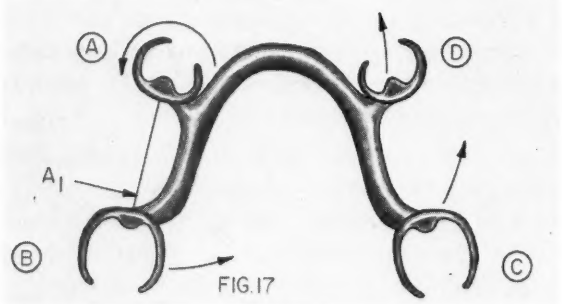

FIG. 17

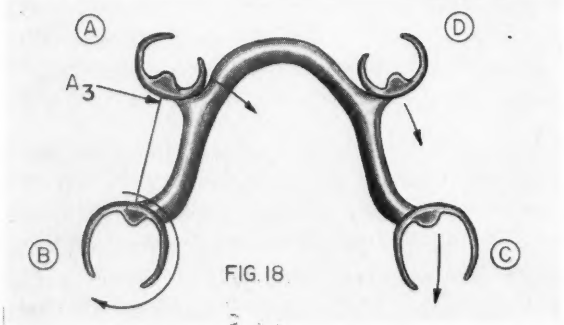

FIG. 18

Fig. 16.—Lateral forces at A_1, A_2, A_3 initiate horizontal rotations parallel to plane of occlusion about different centers of rotation depending on the location of the specific lateral force.

Fig. 17.—Lateral force at A_1 initiates a counterclockwise horizontal rotation about the abutment *A*. Forces on the remaining teeth are indicated by the arrows.

Fig. 18.—Lateral force at A_3 initiates a clockwise horizontal rotation about abutment *B*. Forces on remaining teeth are shown by arrows.

design the partial denture accordingly. For example, if we have a tooth-bounded denture base, such as in Fig. 17, we know that lateral forces at A_1 near the distal abutment B can initiate a horizontal rotational force counterclockwise about the anterior abutment A on that side. If abutment A is short rooted and/or a biscuspid with a round root, the rotational force on that abutment might well exceed its physiologic tolerance. It might be advisable in this situation to splint that abutment with the adjacent tooth with the framework or with castings. Another alternative would be a continuous lingual bar on the remaining anterior teeth. The posterior abutment B (Fig. 17), on the side of the lateral force, will have a lingual force exerted on it. A rigid lingual bar and rigid clasping would help it resist this force by distributing the load to the remaining abutments.

The posterior abutment C on the opposite side would have a mesiobuccal force exerted on it. This can be reduced also by a rigid lingual bar and rigid clasping to all the abutments which would distribute the stress.

The anterior abutment D, on the side opposite the lateral force application, would have a mesial force exerted on it. Simple maintenance or construction of contact points will help prevent overloading this tooth. This can be accomplished by individual restorations or by the framework itself. This same analysis can be applied to the other horizontal rotational forces initiated by lateral stresses near the other abutments.

UNSYMMETRICAL POSTERIOR TOOTH-BOUNDED DENTURE BASES

The pattern of the horizontal and vertical rotation is similar in both the unsymmetrical and symmetrical tooth-bounded denture bases. Obviously, the lever arms are shorter or longer as the case may be and variations in mechanical efficiency result in changes in the amount of stress to each abutment. Due to the changes in location from the center of rotation, the direction of the stress to each abutment may also show slight variations from a symmetrical denture. This can be shown simply by swinging an arc through each abutment from the center of rotation of the horizontal and vertical planes. Care must be exercised in evaluating the case because the changes in the lever arm relationship can dramatically alter the resultant load to a particular abutment.

BILATERAL FREE END DENTURE BASES

If we apply a lateral force near the posterior end of the free end denture base A_1 (Fig. 19), it will tend to rotate about the abutment A on that side, producing a rotating torque on the tooth. The abutment B on the opposite side will tend to tip mesially. Lateral force applied at A_2 in the middle of the denture base will tend to produce the same effect, but the lever arms are shorter. As we approach the anterior abutment on that side with the application of lateral force, say at point A_3, the force tends to produce more and more of the vertical rotational component.

When a case presents a long denture base area with short or round roots on the abutments, such as on the first or second bicuspids, it may be advisable to use indirect retainers and/or splinting to help limit the rotating and tilting action on the abutments. It is particularly important to maintain or create contact

points to distribute the forces initiated by the horizontal rotation. When we apply a lateral force on the free end denture base (Fig. 19), the horizontal rotation initiates a mesial tipping of the abutment on the opposite side. If there is no mesial contact on that tooth, it will take the strain without the aid of force distribution that might be available by interproximal contact of all the anterior teeth. Splinting

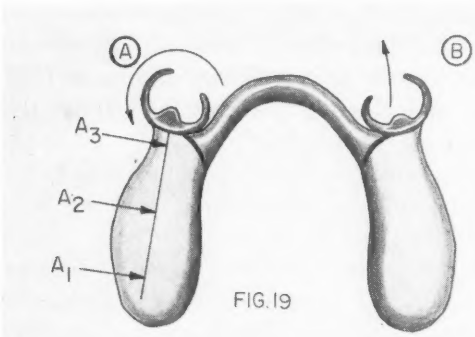

FIG. 19

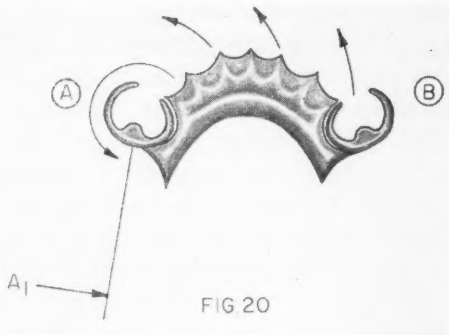

FIG. 20

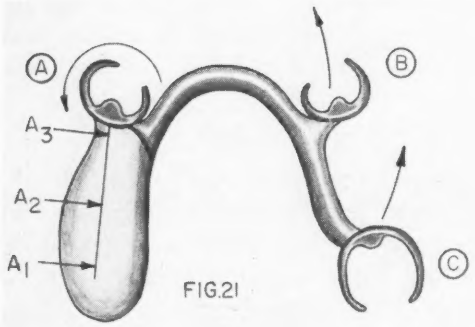

FIG. 21

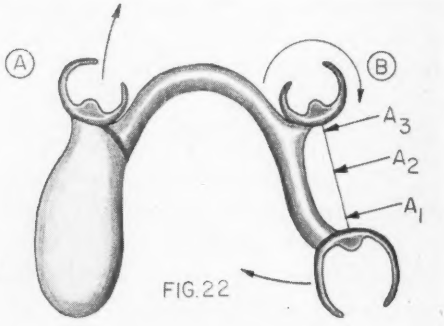

FIG. 22

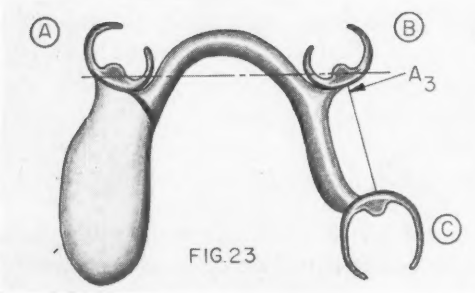

FIG. 23

Fig. 19.—Lateral forces A_1, A_2, A_3 on a free end denture base tend to rotate the partial counterclockwise about abutment A with a mesial force on abutment B.

Fig. 20.—Direction of forces distributed to the teeth are shown due to horizontal rotation initiated by lateral force A_1 with indirect retainer design.

Fig. 21.—Direction of forces distributed to the teeth are indicated due to the horizontal rotation initiated by the lateral forces A_1, A_2, A_3 on the free end denture base of a unilateral partial denture.

Fig. 22.—Direction of forces distributed to the teeth due to horizontal rotation initiated by lateral forces A_1 and A_2 on the tooth-bounded denture base of a unilateral partial denture.

Fig. 23.—When abutment A and B are in the same line, a lateral force near abutment B at A_3 has more vertical than horizontal component of rotation.

with the partial denture framework or by individual castings, as well as indirect retainer design, further reduces this mesial tipping action.

Fig 20 shows the force distribution to the teeth, with an indirect retainer, due to the horizontal rotation initiated by the lateral force applied on the free end denture base at A_1. This design also helps distribute the stress initiated by the vertical rotational component. When indirect retainers are used, thought should be given to the direction of force that will be exerted on the anterior teeth and to the possibility of their moving anteriorly away from the framework. The horizontal rotation initiates anterior tilting forces on the teeth (Fig. 20). Vertical rotation of the framework can also cause anterior tilting stress if the framework rests on inclined lingual surfaces. Even though normal maxillary horizontal overlap causes a lingual force that tends to counteract the anterior drifting of the mandibular teeth, it may be necessary in cases of poor alveolar support to provide reciprocation in the design.

Reciprocation with a rigid framework tends to reduce the tilting action on the anterior teeth caused by the horizontal rotation since it prevents a change in angulation between the teeth and the framework. The anterior stress on these teeth is distributed to the bone more horizontally as pressure on one side of the root and tension on the other.

UNILATERAL FREE END DENTURE BASE

The description of lateral force distribution in the unilateral free end denture base is similar in certain ways to the bilateral denture. A lateral force on the free end denture base side initiates similar vertical and horizontal rotation about the anterior abutment on that side (A in Fig. 21). But it is evident that the added molar C on the opposite side is in the mechanically advantageous position to help resist these forces.

Lateral force on the tooth-bounded denture base side initiates the same general pattern described for the bilateral tooth-bounded cases. Application of lateral force on the tooth-bounded denture base side at A_1 or A_2 (Fig. 22) initiates a clockwise rotation around the anterior abutment B on that side.

If the abutment on the free end denture base side is directly across the arch from the anterior abutment on the tooth-bounded denture base side, then a lateral force at A_3 (Fig. 23) has more vertical component and less horizontal component than when the lateral force is applied more distally as in A_2 and A_1 (Fig. 22).

EXPERIMENTAL MODEL

Since the rotational patterns previously discussed cannot be shown in the mouth, construction of an experimental model was undertaken that would allow us to try the various lateral forces and observe the effect.* Individual teeth were carved in wax to conform with normal anatomy and root structure. These were processed in acrylic resin. The teeth were set in a wax model and invested similarly to denture procedure, except that the whole tooth was present, and not just the crown.

*Niiranen, John V.: Personal communication on model construction.

A pliable resinous material like that used for artificial limbs was placed completely around each tooth. To form a hard base, acrylic resin was finally processed to the teeth held in the pliable vinyl resin.

This completed model was precision mounted by means of four posts on a Lucite base and held by four screws. The model was then cut down the middle; this arrangement allows us to remove one half at a time and to replace it exactly in the same relation to the other half.

Partial dentures of various designs were constructed with the purpose of testing the preceding text on a model which would simulate the *type* of tooth movement found in the mouth. The flexible vinyl resin which surrounds the teeth allows each tooth to move in a similar pattern to that found in the mouth. A moderate lateral pressure on a single tooth will result in a tipping movement of about 1.0 mm., with

Fig. 24. Fig. 25.

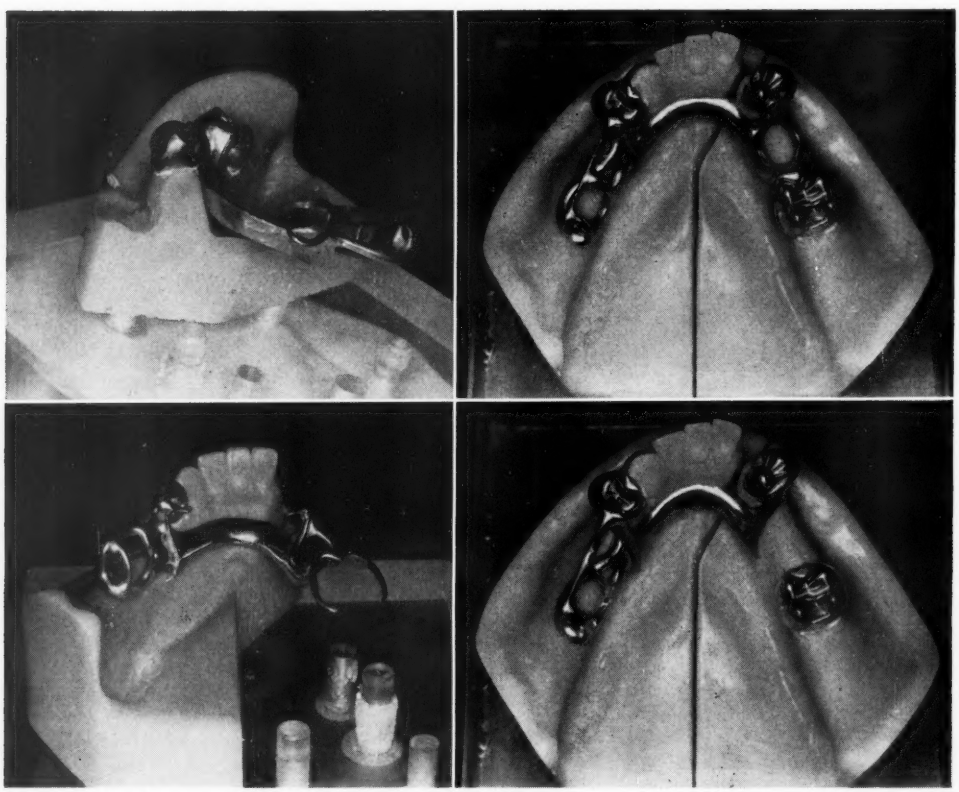

Fig. 26. Fig. 27.

Fig. 24.—One-half of the model is assembled with a partial denture casting in place on the tooth-bounded denture base side.

Fig. 25.—Occlusal view of the completed assembled model with a partial denture casting in place.

Fig. 26.—Lingual view of one-half of the model assembled with a partial denture casting in place on the free end denture base side.

Fig. 27.—Occlusal view of the assembled model with a partial denture casting of a different design in place.

the fulcrum near the apical third. Fig. 24 shows one-half of the model with a partial denture casting in place. (Gold crowns were placed on the abutments to prevent wear.)

Fig. 25 shows an occlusal view of a partial denture casting in place with the model assembled. The free end denture base section of the model is seen in Fig. 26 with the partial denture casting in place. As a lateral force is applied on the free end denture base side, the whole tooth and framework is seen to tip in an arc with the center of rotation near the apical third of the root of the abutment on that side. Here we get a resultant of the vertical and horizontal rotational patterns. By assembling the complete model and repeating the lateral force, the occlusal rests on the opposite side prevent the vertical rotation. The counterclockwise rotation about the free end denture base abutment, due to the horizontal component, is greatly diminished by the two abutments on the tooth-bounded denture base side.

The same procedure was tried with lateral force on the tooth-bounded denture base side, first with one-half of the model as in Fig. 24, and then with the completely assembled model. The results here seem to correlate with and support the preceding text. A different design was then used, where only the anterior abutments on both sides were clasped, as in Fig. 27. Here the horizontal rotation was more exaggerated, as might be expected.

SUMMARY

Lateral force on a partial denture initiates vertical and horizontal rotational components. If the framework and abutments are rigid to each other, the occlusal rests on the side opposite the application of lateral force tend to resist the vertical rotation. This helps prevent the harmful tipping action of the abutments on the side of the lateral force application. Lack of rigidity allows a tipping action of the teeth and prevents the proportionate sharing of the load by the opposite side.

The horizontal rotational pattern depends on the denture base location, the area of the application of the lateral force, and the relative location of the abutments. There are many variable factors, but some general principles can be outlined. Flexibility in the framework or clasping design places most of the rotational stress on one or two abutments. With rigidity, we can rationalize the pattern of horizontal rotation and plan a better design to help resist this tendency and, by so doing, spread the stress to all the abutments.

Unfortunately, variations in tooth mobility that we cannot perceive or measure further complicate every case. It is hoped that this presentation does not seem to oversimplify the problem or claim any panacea, but rather to show some of the torques that are likely to effect the prognosis of our treatment and to point out a rational direction toward which we can work.

With the aid of good roentgenograms, study casts, and accurate clinical examination, we can evaluate the relative resistance of each abutment to the various types of forces that may be exerted on them. Provision can be made then, in the partial design, to prevent overloading and to give a more equal distribution of lateral stress.

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PORCELAIN BAKED TO GOLD—A NEW MEDIUM IN PROSTHODONTICS

S. CHARLES BRECKER, D.D.S.

New York, N. Y.

IT IS GRATIFYING THAT the use of fused porcelain in restorative dentistry has resumed its rightful place in our profession. Although plastics in crown and bridge prosthesis have satisfied, to some degree, the esthetic problems we are constantly confronted with the fact that their color and form are not stable[1] compels us to seek and explore new methods and new materials. Today, there is renewed interest in fusing porcelain to metals. Perhaps this interest is motivated by the annoyance of the fracture of porcelain, the discoloration of plastic in veneer crowns, and the insistent demands by the patients for esthetics. No matter how old the patient or what sex, these demands are great. There are three types of porcelain-fused-to-metal crowns in use today: (1) Porcelain baked to an iridio-platinum alloy, (2) Porcelain baked to a palladium alloy, and (3) Porcelain baked to a gold alloy.

A few years ago, a small group, aware of the possibility of porcelain fused to metal, began work with a special high melting range gold alloy. The baking of a new type of porcelain to this gold seemed to have overcome the weakness of porcelain to a great extent, and fracture was practically nonexistent. The gold casting is specially treated with a refractory wetting agent (red cadmium compound) so that the first layer of opaque porcelain, when baked to this metal, becomes chemically united with the treated surface of the gold. This chemical union prevents separation of the porcelain from the gold. Nevertheless, the possibility of breakage of regular porcelain is always there. Porcelain, by virtue of its chemical and physical composition, does possess the property of chipping and breaking when striking a very hard object at just the right angle. In consequence of the good results achieved by those who have adopted this latest type of restoration, I shall endeavor to evaluate the various porcelain-baked-on-metal crowns in use today. In addition, I will present the management of the construction of the porcelain-baked-on-gold restoration.

PORCELAIN FUSED TO IRIDIO-PLATINUM OR PALLADIUM

Iridio-platinum and palladium alloys are recognized as sluggish casting materials, the management of which is particularly complicated. Their major shortcomings are: extreme difficulty in casting the metals, poor marginal fit, exaggerated contours, excessive percentage of fracture, and unsatisfactory colors of

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porcelain. However, restorations made of these materials contributed to the development of porcelain fused to gold. Platinum, with about 10 per cent iridium added for stiffness, has been used in dentistry for a long, long time, and fusing porcelain to it is not new. The alloy becomes a heavy, slow-melting material which melts close to 4000° F. The fact that it has not met with favor over the years proves its inadequacy. An alloy based on palladium with varying amounts of ruthenium, gold, or platinum is also a slow-melting alloy with unfavorable characteristics which cannot be readily controlled. Upon solidifying from the molten condition, this alloy "spits" like silver, yielding a hollow ingot.[2]

Few investments are available which are capable of withstanding the high temperatures necessary for casting either of these alloys, nor are they capable of compensating for wax pattern shrinkage. The casting technique must be modified for both of these alloys by new waxing procedures. This can be accomplished only with complicated and involved measures. Upon casting, these alloys crystalize, become brittle, and shrink. Skinner[3] writes, "Both platinum and palladium have a strong affinity for hydrogen as well as oxygen. Upon cooling, the absorbed gases are expelled and voids are formed." Because palladium possesses the power of absorbing or occluding hydrogen, the tensile strength of the metal is reduced, and the density during hydrogenation undergoes a change.[4] Both alloys oxidize readily, and this is a contributing factor in breakage because the alien oxide acts as a separating medium. Furthermore, these oxides are often responsible for the poor color of the porcelain. When palladium alloy is heated to a melting redness, palladous oxide is formed. This oxide varies in color from a yellowish brown to a dark, almost black, hue. Because of this oxide there is no bond between the porcelain and the metal, and the porcelain peels off. Another disturbing factor is that both of these alloys undergo dimensional changes when porcelain is baked to them. Therefore, porcelain will have a tendency to chip away if these changes take place when porcelain is fired to them. Such dimensional changes do not occur when porcelain is baked to this special gold alloy. The shrinkage of porcelain is more pronounced when it is fused to either iridio-platinum or palladium alloys.

When the first layer of opaque porcelain is baked to a palladium alloy, a greenish color appears around the junction of the porcelain and the metal in many instances. When regular porcelain is added on this opaque porcelain, the green hue progresses and influences the final color. Porcelain baked on this alloy shrinks so much that it checks or cracks. In order to overcome this checking, heavy layers of opaque porcelain must be applied to act as a cushion for the regular porcelain. We can understand, then, why the color in the completed restorations is so unsatisfactory, in most instances, and why the restorations are bulky and exaggerated in contour.

THE GOLD ALLOY

Pure gold, plus hardening elements which do not oxidize readily and extensively, and to which porcelain is baked, is the better restoration in all respects. This gold* is a nonoxidizing gold alloy with a melting range about 2600° F. The gold is a type C gold which is hard enough to resist biting stress. When the casting from this gold is treated with the wetting agent, and then heated up to

*Manufactured by Noble Metals, Inc., 136 Osborne St., Brooklyn, N.Y.

1800° F., the gold casting becomes even harder. This gold shrinks to a minimum, and the marginal fit is accurate because present day waxes and investments are manufactured to be in compensatory harmony with regards to shrinkage and expansion of gold. No special *investment* is needed, although a special blow torch of oxygen and gas, or its equivalent, is required to melt this alloy.

THE PORCELAIN

Fusing porcelain to this gold produces a restoration of excellent marginal fit and lifelike esthetic colors. The porcelain,* especially manufactured for this purpose, fuses between 1700 and 1800° F. The thermal coefficient of expansion of the gold is compatible with the thermal coefficient of expansion of the porcelain; therefore, there is no "crazing" of the porcelain. The colors have been perfected, with a special type for anterior teeth only, to match all accepted and commonly used shade guides. The porcelain consists of incisal, gingival, and translucent powders. Only a thin layer of opaque porcelain is necessary, and these opacifiers come in white, yellow, brown, and gray colors. The colors are stable and are not affected by the fluids of the mouth.

REQUIREMENTS OF A SATISFACTORY RESTORATION

The requirements of porcelain baked on gold as a satisfactory restoration are:

1. The porcelain must be an accepted dental porcelain with sufficient amounts of feldspar as a base, and fusible at a range where a strong, condensed, and permanent ceramic glaze and texture can be obtained.
2. The porcelain must be so manufactured that the colors are satisfactory, and capable of matching commonly used and accepted shade guides.
3. These colors must be stable and must not change or be affected by the fluids in the mouth.
4. The gold must not produce alien oxides and must not tarnish in the mouth.
5. The completed restoration must be tested clinically and proved successful.

The baking of dental porcelain is an art, requiring special training and experience. Packages of ceramic and gold materials for baking porcelain on gold, which are supposedly easy to manipulate by the untrained, can only hinder the progress in the development of porcelain-baked-on-gold restorations.

TOOTH PREPARATION

The preparation of a tooth to receive the porcelain-fused-to-gold restoration is practically the same as for a porcelain jacket crown, with a few variations. The relation of the shoulder to the gingivae is of paramount importance, in order to prevent gingival disturbances which are so common to the plastic veneer, as well as the porcelain-baked-on-metal crowns. To recommend extending the margin of the preparation up to or just short of the epithelial attachment is impractical and misleading, and often results in tissue laceration. I have never been able to see the attachment from the tooth to the tissue, and I would not recognize one except if it were pointed out to me under the microscope. We do know that

*Gold-Por, 720 So. 13th St., Newark, N. J.

the epithelial attachment is not at the same level on any specific tooth. Were we able to locate these different levels of attachment clinically, we would then construct a crown with uneven, scalloped margins. Since we cannot recognize nor locate the epithelial attachment, why recommend that we extend the preparation up to it? Where, then, should we terminate the preparation for a crown? *I believe that, no matter how deep the gingival crevice is, the preparation should extend very slightly into that crevice.*

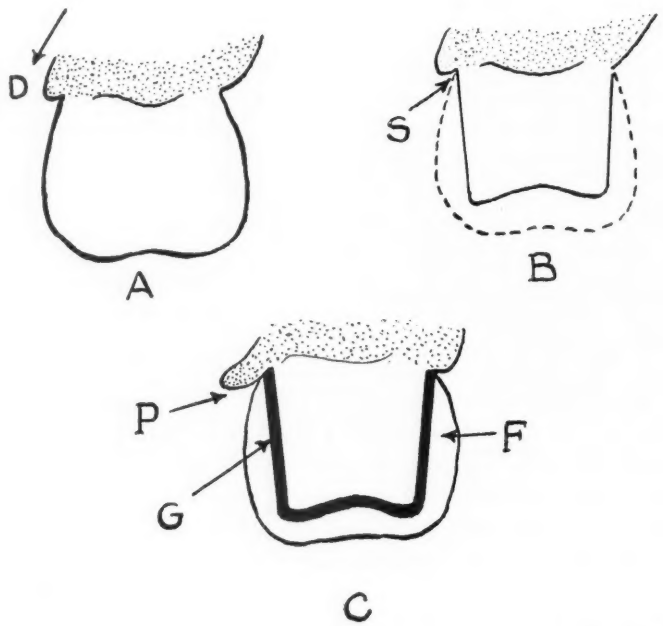

Fig. 1.—*A*, Healthy gingivae around the curvature of the gingival third of the tooth crown as represented by the normal deflecting contour *(D)*. *B*, The shoulderless preparation *(S)*. *C*, The gold casting *(G)*, and the porcelain *(F)*, cannot be constructed to be within the confines of the original contour of the tooth. As a result the restoration is overcontoured and bulky, and distends the gingival tissue, creating a periodontal disturbance *(P)*.

It is wishful thinking to assume that extending the gingival margin of the restorations as far beneath the gum tissue as possible will forestall the exposure of tooth structure when normal recession takes place. Gingival tissues often do not tolerate overextended restorations, and manifest their intolerance by becoming irritated and inflamed. A beautiful restoration loses its natural esthetic appearance when it is enveloped with red, inflamed, and pathologic tissue.

The preparation for a porcelain-fused-to-gold restoration should possess a full shoulder all around the tooth. The cavosurface of the shoulder should be beveled and finished to accommodate the gold casting in the same manner as for a gold inlay. Deep collars should be avoided. The shoulderless or chamfer type of preparation on the buccal or labial surface is responsible for inflamed gingivae. Wheeler[5] writes, "It will be found that the tooth crowns have fairly uniform curvatures at the cervical thirds . . . These contours must be recognized as having considerable physiologic importance." Failure to allow for reproduction of these contours in our restorations accounts for the unhealthy gingivae surrounding many a full coverage restoration. The normal deflecting con-

tour of the gingivae is shown in Fig. 1,*A*. The shoulderless preparation is shown in Fig. 1,*B*. Since no provision has been made in this preparation to accommodate both gold and porcelain, the porcelain cannot be baked to be within the confines of the original contour of the tooth. As a result, the cervical third of the restoration is bulky and distends the gingival tissue (Fig. 1,*C*). Food debris will pack around this exaggerated contour and inflammation results. A shoulder in the preparation makes it possible to have gold and porcelain in the gingival areas, and the restoration can be constructed closer to the original physiologic contour. Any restoration requiring plastic or porcelain in full coverage crowns requires thickness of these materials because color is controlled by the thickness of porcelain and plastic.

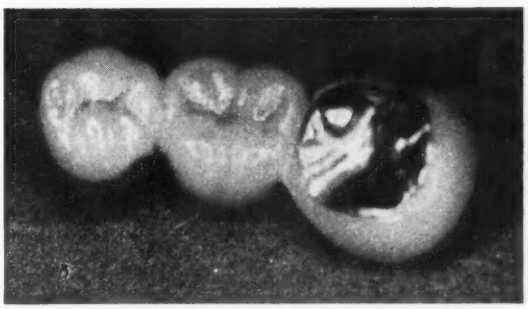

Fig. 2.—If the occlusal vertical dimension does not permit the removal of at least 2 mm. of tooth structure from the occlusal surface, a gold occlusal surface is advised. It can be made to look like a gold inlay.

There are some teeth where it is not possible to prepare a shoulder because of the anatomy, the condition, and the position of the tooth.[6] In such cases, creating a finishing line will help the technician to construct a crown which will not impinge upon the gum tissue. *It is imperative that on such a shoulderless preparation, the gold collar be exhibited in the area where insufficient tooth structure was removed.* At least two millimeters of tooth structure must be removed from the occlusal surface of a tooth to accommodate both gold and porcelain. If the occlusal vertical dimension does not permit this reduction, or if the cuspal thrust of the opposing tooth is hard and heavy, then a gold occlusal surface is advisable (Fig. 2). This can be made to look like a gold inlay.

CONSTRUCTION OF THE GOLD CASTING

Casting a crown or thimble to a burnished platinum matrix facilitates the making of an accurate casting. The investment material seems to adapt itself better to such a matrix. Fold .001 platinum foil over the die in the same way as for a porcelain jacket crown. Cut and fold this matrix with a tinner's joint and burnish well. The crown or thimble is waxed up over this burnished matrix, invested in model Cristobalite investment, and cast. It is imperative that a new crucible be used in the casting machine. Other golds may have deposited some copper or other alien materials along the sides of the crucible. These foreign metals are likely to form objectionable oxides on the new type of gold. Clean and scrub the casting, and if pickling is necessary, use a fresh acid in a clean jar.

Try the casting on the tooth for fit and accuracy. See that the margins do not impinge upon the gum tissue. But most important, *the crown or bridge framework must seat without the aid of a mallet or without the necessity of the patient biting on a piece of wood to help seat it.* By the same token, it should not be so loose that it is easily dislodged from the preparation.

The casting or bridge frame should slip on and off with strong finger pressure. Sometimes, with a bridge frame, linen tape beneath the pontic area can be used to lift and remove the unfinished restoration. If the casting requires excessive force to seat it, the porcelain near the gingival third is liable to crack during the biscuit bake try-in and break away later. If it is necessary to grind the casting, do so carefully and do not perforate the occlusal surface. After trying-in the casting on the tooth, you are ready to select the shade for the porcelain. A Candulor* shade guide is ideal for all porcelain work. The shades are the closest to those of the natural teeth, and will help in selecting the correct color.

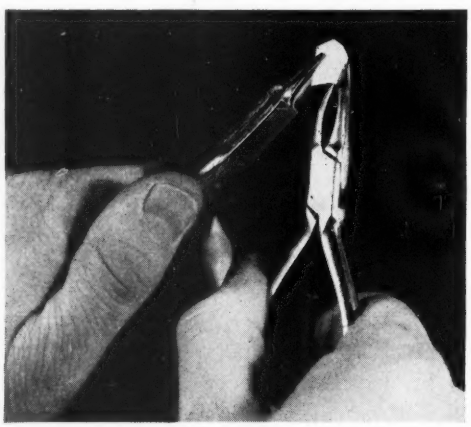

Fig. 3.—When opaque porcelain is baked to the gold, it becomes united chemically. Even when the piece of baked porcelain on gold is bent with pliers, the porcelain will not separate from the metal.

CHEMICAL TREATMENT OF THE CASTING

The gold casting is now ready to be treated before adding the porcelain. Wash the casting thoroughly and dry it in the furnace to burn off any debris. To overcome the adverse effect of the surface tension and to obtain a treated surface on the gold to which porcelain can become united, a special refractory wetting agent (red cadmium compound) is mixed with water. This is painted on the outer surface of the gold with a small brush and allowed to dry. The painted casting is placed in the furnace and heated to 1800° F. When it is allowed to cool, the gold will have lost its characteristic golden sheen, and taken on a darkened, not too smooth surface. Wash this surface and dry it. When some opaque porcelain is baked to this chemically treated area, it unites. Even when we bend the piece of baked porcelain on gold up to a 45-degree angle (Fig. 3), the porcelain will not separate from the gold although it will crack in one straight line as will the gold.

*Swissedent.

BAKING THE PORCELAIN

Mix some yellowish opaque porcelain with distilled water in a dish, and paint it on the casting with a small flat brush. The color of the opaque porcelain should blend in with the body color selected. A too white opaque is often responsible for the feathery appearance so often found around the necks of the porcelain-baked-to-metal crowns. Preheat the restoration in the furnace, and fire to 1800° F. so that it can fuse to the treated gold surface. After cooling, apply a thin second coat of opaque, but this time fire only to 1600°. It is better to apply two thin coats of opaque than one thick one. Wet and mix some selected Gold-Por porcelain in a small dish. The feel in mixing this new type of porcelain is altogether different than the feel in mixing other porcelain. It has a pasty consistency and does not flow readily when it is applied to the casting. *It must be pushed along.* Wet the opaqued casting with distilled water before applying the porcelain because it will flow easier. You have to keep pushing this mixed material, otherwise it may lump up in spots or trap air bubbles. Build up the porcelain to the maximum fullness, then shape and carve it with fine knives and small spatulas. The built-up restoration can be carved even when it is dry, but do not add water to it.

An important advantageous phenomenon is that this porcelain shrinks very little. The shrinkage which may occur is so infinitesimal that it is not noticeable. Because of the minimum shrinkage, it is not necessary to ditch around the cervical margin as is customary when using other porcelain. Place the carved restoration on a tray, heavily padded with a very fine silex to distribute the heat uniformly. Preheat, then fire to 1800° F. for the biscuit bake. Although this is a medium fusing procelain, it takes the same length of time to fuse as does high fusing porcelain. Cool the biscuit bake slowly. It must be absolutely cool before it is carved with stones. Try the biscuit-bake restoration on the tooth or teeth, and be sure not to exert undue force to seat it. Test the contact areas with thin narrow strips of articulating paper, and grind away the marked porcelain that binds or prevents seating. Use small, true, not too coarse stones to grind this porcelain. Large, old, diamond stones, or coarse Carborundum stones tend to rip and jar the porcelain and the gold, setting up conditions which may contribute to fracture later on. Syltex stones used on a moistened biscuit-bake restoration maintain a smooth surface. After the crown has been shaped, fill in all defects caused by the grinding with additional freshly mixed porcelain. Fire this second bake to 1775° and the final bake and glaze to 1750° F.

INDICATIONS FOR PORCELAIN-BAKED-ON-GOLD RESTORATIONS

Porcelain-fused-to-gold restorations can be used as individual crowns with practically no metal showing. These are ideal for veneer crowns (Fig. 4). I feel such porcelain veneer restorations will replace the plastic veneer crown. Fracture does not take place and the color is beautiful and remains so. I am in accord with Bastian,[7] who said that we are approaching the day of reckoning regarding the acrylic-faced gold crown. I feel sure that the porcelain-baked-on-gold veneer will bring that day of reckoning close to us. It is indicated where there is a small interarch distance where esthetics is so important, and may be used in abutment retainers and pontics in small and large bridges. When the casting is subjected

to stress, it will not "give" or "spread." As long as the gold will not "give" the porcelain baked to it has less chance for fracture.

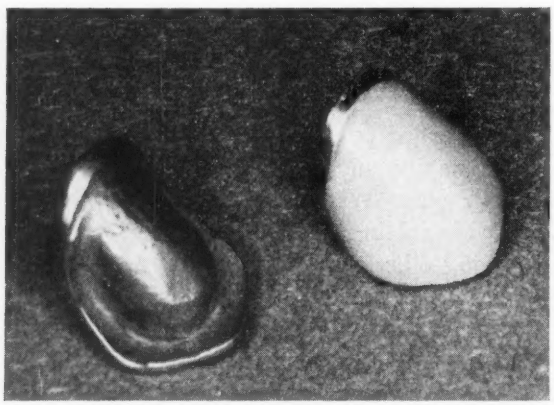

Fig. 4.—Porcelain baked to gold is ideal for a porcelain veneer crown. Fracture does not take place and the color is stable.

The pontic castings are joined together with the abutment retainers by means of a special gold solder. This solder melts at temperatures slightly above 2000° F. The opaque porcelain is baked to the soldered framework, and after the biscuit bake, the restoration is tried in the mouth. Then the restoration is completed. If you desire to cement in such a restoration temporarily, do so with a mixture of cement powder, petroleum jelly, and a few drops of eugenol. Zinc oxide and eugenol pastes without a petroleum jelly base cannot be considered as temporary cements. Many restorations remain in the mouth after cementation with a zinc oxide and eugenol paste because it was impossible to remove it without damaging or permanently impairing the crown or bridge. Porcelain baked to gold can be used in a cantilever bridge, such as a central incisor carrying a lateral incisor. If the high glaze on the lingual surface is removed, and the surface polished to a satin finish with a rag wheel and pumice, the damaging hardness of porcelain is reduced to a great extent.

If the occlusion is extra close and a restoration is indicated, abutment retainers of porcelain veneer crowns are advised (Fig. 5). The lingual surfaces of the pontics are cast in gold, and porcelain is baked to the modified castings. The biting or shearing force does not contact the porcelain, and the color of the porcelain is stable and satisfies the esthetic requirements. Inasmuch as the porcelain cannot peel away or separate from the metal, such restorations will not fracture.

Sometimes we are confronted with a condition where the occlusion does not permit the construction of a porcelain jacket crown (Fig. 5). The gold collar on the labial surface of the casting may contribute a bluish discoloration around the gingivae. To avoid this, the casting is constructed without a collar of gold on the labial surface (Fig. 6). In order to butt the porcelain against the bared shoulder like a porcelain jacket crown, it is necessary to burnish a small piece of platinum foil over part of the casting, and slightly over the labial shoulder. Use .0001 platinum foil for this purpose, and bake the porcelain to it. This thin piece of platinum can be removed or even permitted to remain.

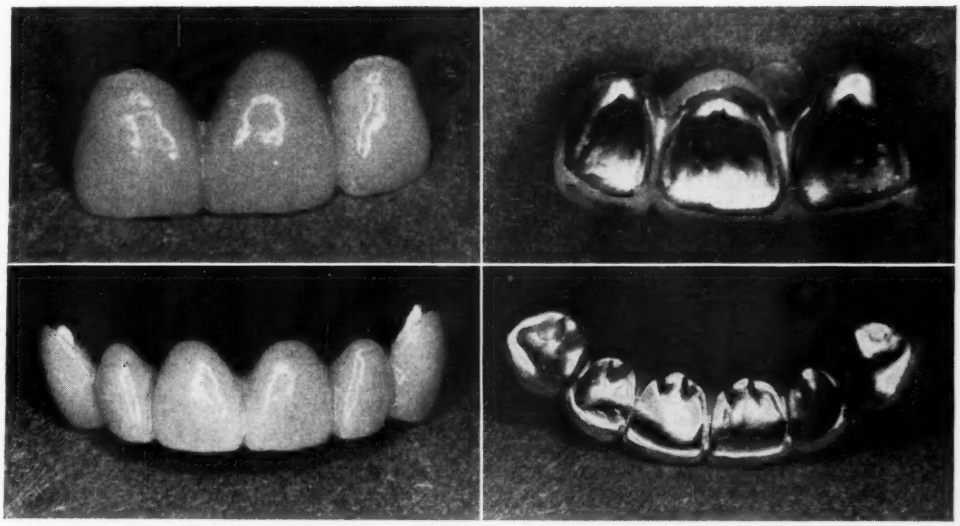

Fig. 5.—The lingual surfaces of the pontics are cast in gold, and porcelain is baked to modified castings in bridges for reduced interarch distance replacements. Note the linguo-incisal stain on the three-unit restoration.

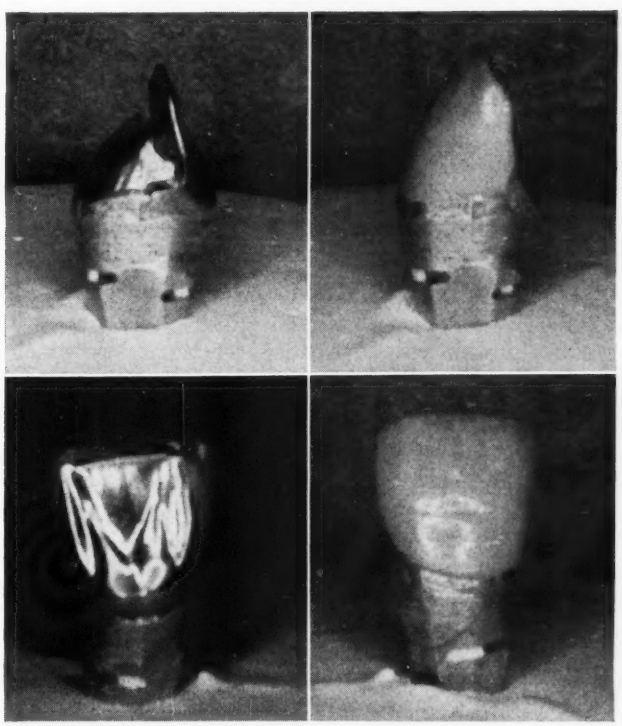

Fig. 6.—A veneer crown for an anterior tooth can be constructed without a gold collar on the labial surface for esthetics. In order to butt the porcelain against the bared shoulder like a porcelain jacket crown, it is necessary to burnish a small piece of very thin platinum foil over part of the casting and over the labial shoulder. The restoration can be made to look like a porcelain jacket crown.

Porcelain fused to gold can be joined together as multiple abutments or splints. This material is recommended because the soldered connections are near the incisal edges. Therefore, the interproximal areas can be kept clean, and the interdental papillae can be stimulated. A buccal arm clasp for a partial denture which rests upon the widest diameter of a plastic veneer crown on an abutment tooth soon wears away the acrylic resin, and the partial denture will settle beyond the limits to which it was intended. Such a clasp will maintain its position over an abutment retainer constructed of porcelain on gold.

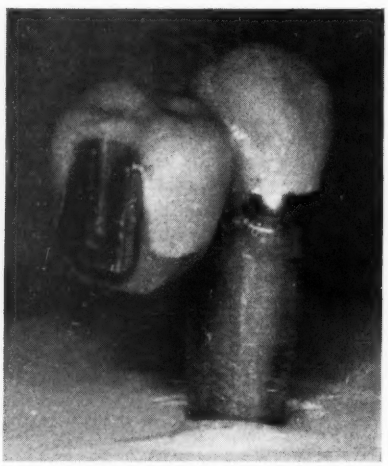

Fig. 7.—Porcelain baked to gold is indicated to receive precision attachments in retainers for individuals who insist upon esthetic restorations in the lower jaw.

If you are daring, porcelain baked on gold may be used to receive precision attachments in abutment retainers for individuals who insist on esthetic restorations in the lower jaw (Fig. 7). This new material is not introduced to take the place of the porcelain jacket crown, porcelain coping bridges, and the like. It is another type of restoration to add to the porcelain work which has proved so satisfactory over the years. I recommend that small types of restorations be attempted at the beginning, such as individual crowns, porcelain veneers, and two- to four-unit fixed bridges. Do the preparations carefully. Pick your cases at first, and very important, select patients who will cooperate with you and with this new material.

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THE USE AND CONSTRUCTION OF GOLD CROWNS WITH A FUSED PORCELAIN VENEER—A PROGRESS REPORT

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THIS IS A PROGRESS REPORT pertaining to the fusing of a porcelain veneer to a gold casting. The initial efforts were directed to formulating a gold alloy with color and physical properties in line with those of other gold alloys used in crown and bridge construction, and with a fusing temperature which would allow it to be worked by using standard office laboratory equipment and to which the porcelain to be developed would bond. The requisites of the porcelain included: the ability to adhere to the metal; to have strength, toughness, color stability and acceptable shades in harmony with those of natural teeth; to hold form and texture; to be nontoxic; to have "life"; to have or be capable of simulating translucency.

The research projects associated with making the basic alloy and porcelain are of little interest to anyone other than a manufacturer of such products. The following tests were made to prove the validity of the planning and engineering.

CORROSION TESTS

In addition to mouth tests, the porcelain has been subjected to accelerated corrosion tests in the laboratory to determine the resistance to attack by mouth fluids. The synthetic saliva used was developed, for Columbus Dental Manufacturing Company by the Ohio State University, after extensive sampling of saliva conditions found in the human mouth. The reliability of the test has been proved by checking against practical results over a period of more than twenty years.

The sample under test is suspended in the synthetic saliva, which is maintained at a temperature of 180° F., for a period of five days. A control porcelain especially developed to be slightly corroded in the mouth is tested simultaneously to be sure that the test conditions are correctly maintained. At the end of the test period the control sample should be corroded but the test sample should not be if it is safe to use in the mouth. Neither the opaque nor body porcelains showed any corrosion.

ADHESIVE BONDING TESTS

Laboratory tests were made to determine the adhesive bond between the metal and porcelain fired to it. The test method used is a modification of that

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described by Swartz and Phillips[1] for the measurement of adhesive characteristics of dental cement. In this test, two rods of the cast gold 3/16 inch diameter, threaded on one end and faced flat at the other, are held in axial alignment in a special fixture and joined with a thin layer of porcelain. This assembly is placed in a standard dental porcelain furnace and fired in the usual manner. The threaded ends of the rods are held in the self-aligning clamps of a tensile testing machine and the load required to pull them apart is measured.

The results of a typical series of eight samples, made of the special cast gold and opaque porcelains, range from 4,850 to 7,050 pounds per square inch, with an average of 5,620 psi. In every case, the break occurred through the porcelain rather than at the interface, showing that the bond is stronger than the porcelain. Soaking the sample in water for 48 hours immediately before testing did not affect results appreciably. The rather wide spread in breaking loads may be due in part to failure to maintain perfect alignment of the gold rods during firing of the porcelain.

DYE PENETRATION TEST

In the dye penetration test, the sample is immersed in a solution of fuchsin dye in alcohol. The alcohol and dye penetrate into very small pores, cracks, and seams, and the strong red color of the dye makes such defects readily apparent. Frequently, defects that were not detected with a binocular microscope were disclosed by the dye.

These tests showed no significant difference in permeability of surface of the experimental porcelain as compared with other dental porcelains. Perhaps the most significant result was that in no case was there any perceptible penetration of the dye between porcelain and gold of a composite structure of the special porcelain and cast gold. This is further evidence of the close union between the two.

There is no indication that vacuum firing affects the bonding, and little or no difference occurred in the penetration test after vacuum firing.

FLEXURAL STRENGTH

In testing for flexural strength, a porcelain rod, approximately ¼ inch square by 1 inch long, is supported at the ends and loaded at the center until breakage occurs. The breaking strength or Modulus of Rupture in pounds per square inch is computed from this formula:

$$M = 1.5\ I\ \frac{W}{bh^2}$$

When
- M = Modulus of Rupture
- I = Distance between end supports in inches
- W = Breaking load in pounds
- b = Width of sample in inches
- h = Height of sample in inches

That the strength of the experimental porcelain is greater than that of other dental porcelains tested is shown in the following table of Modulus of Rupture test results.

TABLE I.

MODULUS OF RUPTURE

Neyoro Porcelain	9,020 psi
Ney's Opaque	8,570
Porcelain A—Low Fusing	7,130
Porcelain B—Medium Fusing	7,400
Porcelain C—High Fusing	6,600
Porcelain D*—High Fusing	7,100

*Porcelain D is intended to be fired on cast metal structures.

These tests have been checked, in part, in the Dental Materials Department of Indiana University School of Dentistry; additional tests will be made.

THE GOLD ALLOY

The gold alloy, which has a fusing range of 1880 to 1930° F., can be melted and cast with a blowpipe which uses a mixture of commercial gas and air; the soldering can be done with the same type of flame. The alloy can be cast to any desired sharpness of margin, and to any degree of frictional adaptation. It can be polished to the same brilliance as other alloys. On some occasions it has seemed to develop gas pits more readily than other alloys. Because of this, greater emphasis has been placed on fluxing the metal during the casting process.

Soldering is difficult because of the high fusing point of the solder, which is 1800 to 1830° F. There is little danger of spoiling the castings during soldering because of the safety range of from 80 to 100 degrees between the two fusing points. For this union of alloys, cleanliness, access, contact, and proper heating are doubly necessary. The porcelain matures at 1650° F., providing a margin of safety of at least 150 degrees when the veneer is applied to the crown or fabricated metal structure.

In their present form and with the combinations used, a toxic effect from these materials is impossible. A positive seal has been created by what appears to be a chemical union.

STRENGTH OF THE PORCELAIN

As was shown in the Modulus of Rupture Tests (Table I), the strength of the porcelain itself compares very favorably with those which are designed to be formed and fused by the dentist or technician. In fact, the strength of the porcelain, when fused to the alloy, is astonishing. It is difficult to break even when heated and plunged into water, and when a break is effected, examination will show that the shear occurred in the porcelain, leaving the bond with the metal intact. When ground, it has a "toughness" not often found in specimens fabricated by hand.

COLORS OF THE PORCELAIN

With the basic shades now available, the New Hue shade guide can be substantially approximated—certainly near enough for practicability. Stains and an overglaze are obtainable. As yet, under changing light situations, some phases of translucency may not be duplicated satisfactorily. To date the color stability is dependable.

It is the opinion of those who have used this porcelain as a veneer that, when familiarity with its use has been furthered, less time will be needed for finishing the restorations than when plastic veneers are constructed. Also this same familiarity should perfect the "knack" of shading, which has been the only real problem in recent months.

In view of the variations from the normal found in all commercial shade guides, and the fact that each tooth to be matched has its own peculiar deviations from those same standards, it is no wonder that trouble is encountered in matching shades. Up to the present time, modifications in shading formulas have depended to a great extent on the experience and trained eyes of individuals engaged in the manufacture of artificial teeth and facings, and on the suggestions of dentists and ceramic technicians. It is my personal prediction that future standardization may be guided, at least in part, by analyses made by using the Hunter Color and Color-Difference Meter.

I have no desire nor intention to deride plastics and the use of plastics as a veneering material. Beautiful esthetic results can be obtained by their application to exposed surfaces of gold castings. Care in constructing the retentive frame, cleanliness, and a proved packing and curing technique will do a great deal to eliminate color instability.

However, it is true that protection is necessary, and that wear does occur with the materials now in use. The protecting metal frequently frustrates the artistic endeavor, while the surface texture, a necessary adjunct to shading and lifelike appearance, is destroyed through abrasion. Plastic will stain occasionally, and, in the more static areas, it collects debris more quickly than either gold or porcelain.

In the mouths under my observation, when in contact with the ridge under pontics, it has been noted that resin can be more irritating to tissue than a highly polished, correctly formed gold saddle.

In this age of constant advancement in dental materials, I am confident that eventually better plastics will be offered. In the meantime something is needed *now*—which will provide a surface capable of receiving masticatory thrusts and pressures; which will be capable of covering areas of metal now of necessity exposed; which will assure color stability in all cases; which can withstand abrading actions and retain surface texture and form; which has maximum resistance to fracture; which can reproduce tooth form; which can be "characterized"—if I may use such a term; which will be biologically acceptable; which will attach to the metal support; which in shade and color distribution can match natural teeth sufficiently well so that when *one* restoration is needed and placed, harmony will result without the need for multiple construction. The original assumption was that such a porcelain could be produced.

ERRORS AND DIFFICULTIES

A few errors were made, both in assumption and in technique. Some were discovered in one effort; others have taken the long way around.

When an attempt is made to fuse several porcelain teeth or pontics as one continuous unit around a bar, warping results. This should be expected and accepted without argument. Also, when a frame unites two or more retainers aligned to seat on prepared abutment teeth, each having a common line of insertion, no technique may be employed which warps that structure, if it is to be seated, or if it is expected to fit after seating.

Likewise such a technique cannot be employed when using the materials about which I am speaking. The porcelain must be applied to separate units, each with its own center of shrinkage. If such a principle is strictly adhered to, no distortion of the metal part occurs, and no machining and no orthodontic movement of abutment teeth are required.

One such bridge served to demonstrate this fallacy, but a number of such tests were made, each reacting similarly. While three surfaces of one pontic can be covered with a continuous veneer of porcelain, too many applications are necessary to accomplish this. It is better and easier if two surfaces are combined, with the third separated from the others with a flange of metal.

The first series of powders included opaquing materials in several basic shades. At present only one opaque porcelain is made—a white—to which porcelain powder or SSW 1600° stain of the desired color can be added. This produces an undercoating of the same shade family, but usually lighter. Granger* raised the question as to the possibility of the white or lighter opaque being responsible for some of the shade discrepancies. Such a presumption sounds logical. While similar variables were noted with those veneers made using the initial shaded opaques, many clinically acceptable veneers have been made with each. However, at the present time at the University and in the hands of others who are continuing the experiments on shades, colored opaques are being used again. As I see it, the answer is to be found in repeated use of either.

FUSING TECHNIQUES

Quite an assortment of fusing techniques has been used, including vacuum firing. Some of the changes have been calculated, while others have resulted from accident or perhaps carelessness. A group of laboratory ceramists, who were invited to use this gold and porcelain and comment on its possibilities in the light of their experiences, intentionally did many things contrary to the specified technique. Surprisingly enough, very few accidents resulted, but casual tests of their fused specimens indicated that some of the structures were substandard.

This combined test did show that a technician can "get away" with many digressions, but that the outlined technique will yield sound specimens *uniformly;* specimens of a type which respond as desired to all demands of the testing program.

The size of the furnace muffle may present a problem. There is equipment available with interior dimensions capable of accommodating a large prosthesis,

*Personal Communication.

but whether or not the temperature increase can be controlled as desired, and is uniform throughout, I do not know. Inasmuch as such control and uniformity of temperature are extremely important, these points should be thoroughly investigated.

Variations in resistance, or in the proximity of the wiring to the surface of the muffle, as well as the fit of the furnace door, can cause unevenness in the maturing of the separate units, as is true with any porcelain. Individual bulk requirements of veneers on crowns and pontics will contribute to this fusing problem. In the construction of a bridge which requires veneering of retainers and pontics, it is well to fire one layer of porcelain on the pontics first, and then continue with all of the units. Rotation of the position of the bridge in the muffle for each of the firings necessary partially solves the above-mentioned problem.

Retentive undercuts are not needed; in fact, it is my belief that if they were present on the surface of the gold casting to be veneered, the porcelain structure would be weakened during the shrinking which occurs when the material is fused, because of the strain pattern set up in the porcelain. I have no evidence to support this assumption except my observations of what happens when attempts are made to veneer several sides of a rectangular bar.

These questions have been asked: "How much support is required for the veneer on an anterior pontic?" "Will the veneer remain on a flat surface with no flange extending labially over the ridge?"

Theoretically, from the results of the testing program, such support is not needed since there can be no "slip" of the veneer. Fracture may occur, but, considering the lines of force, the fracture would be through the porcelain and at such an angle that the cervical shelf would not have prevented the accident. We do use the cervical shelf in the form of a so-called saddle, or ridge lap. This is done more for the sake of convenience than for retention, inasmuch as it does facilitate adaptation and condensation, and makes it easier to regulate form, ridge coverage, contact, or the lack of contact.

In our work, we have had three veneers come loose at the completion of the biscuit bake. This occurred twice on one crown and once on another, both being lower cuspids. In the construction of a lower posterior bridge, the veneer which was fused to the flat underportion of the pontic came loose several times. A portion of the opaque remained attached to the gold, but, from at least half of the surface, both the opaque and the porcelain flaked off. We have no explanation for this. At no time during the testing program was this deviation from the expected adhesion noted. Each unit, where this difficulty was experienced, was completed satisfactorily and is now in service in the mouth.

Tests have been initiated to try to duplicate this phenomenon routinely in order that its cause may be determined. I might say that each application which "popped off" had been fired in a suspended position. In the future, such surfaces will have some planes meeting at angles and the bridge will not be placed in such a position in the furnace that any section of the veneer is "hanging" during fusing.

CLINICAL RESULTS

Of the seventy-five or more units in service, approximately forty-five have been in the mouth for more than six months, and several of these for more than a year. Any breakage which may occur after this period of time must be considered as an accident. Those who construct porcelain jacket crowns should agree with that statement.

I emphasize that when the condensing, drying, and fusing of this material have been done *with care* and *according to the procedures to be outlined,* strength and adhesion to resist normal forces will be ample.

We have used these materials in the following situations:

1. In upper and lower cuspid and bicuspid veneered crowns to support and retain clasps of removable partial dentures. (In three instances the area under the retentive clasp arm, each contoured of wrought wire, has shown a line of discoloration. It has been assumed that these marked veneers were more than normally porous. This has not occurred under cast clasps.)
2. In upper and lower cuspid and bicuspid and upper lateral incisor veneered crowns for restorative purposes only—the last with unsupported incisal edges.
3. In lower posterior bridges with veneered bicuspid retainers, veneered pontic occlusal surfaces, and veneered pontic cervical ends.
4. In lower posterior bridges with veneered occlusal surfaces of bicuspid or molar pontics.
5. In lower posterior bridges with extremely short pontics occlusocervically. In these replacements, the area of contact between the pontic and the ridge was veneered.
6. In upper anterior three-unit bridges with two veneered crowns as retainers and one veneered pontic.
7. In the construction of a lower six-unit anterior bridge. (The porcelain was fused on the pontics and on the cuspid crowns to which the female portions of precision attachments had been soldered. These supported and retained a Class I partial denture. While this is the only restoration of this type we have in service, a number of similar crowns have been fabricated during the testing program. No distortion of the attachments has been shown from the application of the porcelain veneer.)
8. In the construction of an upper anterior two-unit bridge with a lingual rest on the approximating tooth.

As a veneering material for crowns constructed in the preparation of mouths for clasp-retained removable partial dentures, this porcelain has become essential in our clinical routine. It serves extremely well when used on crowns made for lower bicuspids, especially short or abraded lower bicuspids which are subjected to unusual loads and occlusions. It seems to be equally suitable on upper lateral incisors, regardless of whether or not the incisal area is protected by the casting.

When used as an occlusal veneer on lower bicuspid and molar pontics, it has resisted breakage. In the biscuit state, the porcelain can be ground to a form compatible with the occlusal pattern necessary for the lateral and protrusive occlusions. Producing a glazed surface by fusing the porcelain will sometimes

destroy the relationship with the opposing surfaces. We have found overglazing to be the best method under such circumstances.

CASTING TECHNIQUE

The technique for investing patterns to be cast with this alloy need not be different from that used routinely.

The casting must be pickled. All surfaces except that which is to receive the veneer are polished. Then the veneer area is cleaned with a bur but *not* polished. It is washed with a detergent to remove all polishing material and grease; then it is rinsed and dried.

OPAQUING

The opaquing material is now applied. Since this comes in a white only, any shade or any amount of the porcelain or stain can be added. It is possible, in this way, to secure an undercoat of a harmonious color which may be either light or dark as desired.

In all cases, the first application of porcelain to the polished and cleaned casting is made with the opaque material. The opaque material is mixed with distilled water to a creamy consistency, and painted on the metal in a thin layer. The layer should be just thick enough to cover the gold completely, but not be so bulky as to reduce the thickness of the subsequent body layer any more than is absolutely necessary. In general, a thickness of about 0.25 mm. of opaque material is sufficient. The opaque material is carefully applied only in the area to be veneered and should not be carried beyond the margins of the veneer area. If some is accidentally carried over the margin, it should be removed, as it is difficult to grind off after firing. When completely covered, the crown is placed on a tray in front of the open door of the previously heated furnace muffle to dry the moisture from the opaque material.

When the tray and crown are placed inside the muffle, the temperature should be at or below 1100° F. The door is closed, and, when the temperature reaches 1100° F., the timing is started. The temperature is raised 100° each minute the rheostat being manipulated to keep the increase at this constant rate. When the temperature reaches 1550° F., the crown is removed without any holding time and placed under a glass tumbler or beaker so it will cool slowly enough to prevent cracking.

The opaque should not be carried to 1650° F. at this stage. Since it must have at least one more and often two or three more firings when the body is applied, it will reach its full maturing point in these firings. The appearance of the opaque layer at this point should be that of a "biscuit," i.e., it should not have a glazed finish.

After removal from the furnace, this application must be examined critically for texture and thickness, and for completeness of coverage. If metal shows through in spots, opaque can be added in such areas and fired at the same time as the first layer of the porcelain.

SHADING THE PORCELAIN

The shades as manufactured can be blended according to formulas which will match the New Hue shade guide. This is a tricky process but not more so than with other veneering materials or porcelains. While our results at Indiana University have not been altogether successful when using the combinations and amounts recommended by the manufacturer, I am optimistic about overcoming these obstacles. Progress is being made through experimentation.

If it could be arranged for Dr. Dykema or me to spend a few weeks doing nothing but constructing crowns and bridges clinically, each unit having a veneer, a proficiency could be attained which would enable us to shade instinctively. Since that has not yet been possible, we are following a winding path which, although forward, is certainly not the shortest distance between two points.

I am mentioning, for the third time, the need for a close acquaintance with the shading idiosyncracies of this porcelain (or for any other porcelain, for that matter). This repetition occurs in order to stress its vital importance.

THE PORCELAIN VENEER

The porcelain is mixed with distilled water and is applied according to the chosen shade pattern. Upon application, it is vibrated to remove all moisture and for condensation. It should be built to an overcontour, particularly at the margins, but it should not be extended beyond the margins. This overcontouring may often avoid the necessity of another firing to fill in slight discrepancies at the margins and in over-all form. Brushing and spatulation may be employed provided a smooth surface results.

Next it is dried slowly and thoroughly to avoid minute cracks, and placed in a furnace at 1100° F., elevating the temperature 100° per minute until the temperature is brought up to 1600° F. Then it is removed and cooled under a glass, and the margins are stoned to remove any excess beyond the margins.

In the construction of veneers for clinical use, a second application usually is necessary. It is applied to contour or very slightly in excess, condensed, dried, and fused at 1650° F. In case it is expected that no further contouring will be necessary, it is held at this temperature for from one to two minutes, which results in a good surface. If the veneer must be contoured after fusing to furnish a retentive undercut or to occlude with opposing teeth, *do not* hold the temperature at 1650° F. Instead, contour the porcelain and use the overglaze.

STAINING

The staining technique is the same as for facings when a glaze of 1600° F. is used. While glazes in this fusing range are satisfactory when fully fused, the one which has been provided for use with this porcelain did not work easily in our hands at the beginning. It does not "flow" as readily as some of the others on the market when applied in a thick layer, and it occasionally has shown a tendency to "bubble" or have a "mottled" appearance.

The coating applied must be thin and of an even thickness and scrupulously dried before being placed in a relatively cool furnace. Firing should not be pro-

longed above 1600° F. A second coating may be necessary to produce the desired texture. With this routine, very satisfactory surfaces can be obtained.

PREPARATION OF TEETH

Teeth to receive this porcelain veneer are prepared in the same manner as they are for crowns which have resin veneers. Just as much depth is necessary, especially on the shoulder and at the incisal angles. When the veneer is to be constructed with the incisal edge unprotected by metal, the preparation must be reduced in length. Shoulders should go into the interproximal areas beyond the line angles, and may be cut at a slight angle (not more than 10 to 15 degrees) to the long axis of the tooth.

REPAIRS

As yet we have not been faced with the task of repair, but much thought has been given to this subject. The first time a veneer does break the following method of replacement will be attempted:

1. The remaining porcelain, either bulk or thin film over the gold casting, will be removed.
2. The gold casting will be cut back as much as is possible or until an added depth of 0.33 mm. has been gained. I would not be concerned if, in spots, the preparation were exposed.
3. The shoulder portion of the casting can be beveled approximately 10 or 15 degrees, making certain that it has been increased in width.
4. Four postholes will be sunk into the casting, their placement as widespread as possible. These should be tapered and approximately 1.25 mm. deep.
5. A plate, as thin as easy handling will permit, will be waxed into the area of the veneer. A small truss rod of wax will be attached for removal; this plate will then be sprued and cast.
6. The plate will be fitted to the tooth and finished as thin as judgment dictates.
7. A new veneer will be fused to this casting, trying it in the mouth for contour and occlusion.
8. The repair will then be cemented in position with plastic cement.

As I stated before, there has been no call for repair, but I believe this plan would suffice.

CONCLUSIONS

1. It is possible for more of the metal structure to be veneered with fused porcelain, and it can be done with a feeling of safety against breakage, wear, and loss of surface texture.
2. Color stability, marginal seal through possible chemical bonding, ease of manipulation with low-cost equipment normally found in the dental office laboratory, and a short working-time factor have been achieved.
3. Under a majority of conditions, the finished veneer has a lifelike appearance.

4. Incisal translucency is not yet possible with this low-fusing porcelain, and I am advised that the manufacturer is aware of these limitations.

5. Producing shades which match and harmonize with the shade guide and teeth is a matter of individual experience in compounding the basic shades. With continued use of the material, we have improved our shading, and we have diminishing worries on that score.

It must be recognized that vacuum firing will darken the color, that atmospheric conditions vary from office to office and may affect color, and that thickness of the material, the color of the opaque layer, the relative thickness of the porcelain and opaque material, and the contour of the veneer all play their parts.

6. The overglaze can be applied and fused to a satisfactory texture provided the applications are thin and repeated when necessary.

7. Staining is easily accomplished, and can be used to improve or alter shading and to simulate translucency.

8. Tooth form of any type can be reproduced.

9. When tooth form and surface texture have been correct, the materials have been biologically acceptable.

10. For veneering crowns which are to receive clasps or attachments, this porcelain is indispensable.

It is our considered opinion that with this technique a long stride forward in dental restorations has been taken, and we anticipate that in the future it will have a widely diversified application.

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A TECHNIQUE FOR TEMPOROMANDIBULAR JOINT ROENTGENOGRAPHY

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ROENTGENOGRAMS ARE VALUABLE IN the diagnosis of temporomandibular joint pain and dysfunction. By providing a two-dimensional view of the hard structures of the joint, they give information as to anatomy, pathology, and physiology of the temporomandibular joints.

Techniques available for temporomandibular joint roentgenography are many and varied. Each of them serves a purpose. No single technique is adequate to furnish all the required data for every case. In a subject as complex in its structure and function as is the temporomandibular joint, it is often necessary to use more than one projection to obtain adequate data. In some cases, it is necessary to use special techniques, such as laminography. Arthrography has also been suggested.[1]

THE UPDEGRAVE TECHNIQUE

One of the most useful techniques is the oblique lateral technique developed by Updegrave.[2] In this method, four to six spot exposures are made on an 8 x 10 film in a cassette fitted with detail screens. The cassette is positioned in an angled slide tunnel, which is equipped with guide rods for positioning the x-ray tube, and a plastic earpiece and adjustable protractor for positioning the patient[2] (Fig. 1). This technique does not give a true lateral profile of the hard structures of the joint, due in part to the angle and in part to the short anode-film distance which causes enlargement of the image on the film. The oblique lateral technique does, however, result in an image in which bony outline, relative density, condyle-fossa relationship, and the range of condylar movement in the opening movement of the mandible may be observed. In addition, the Updegrave apparatus is well suited for office use. The following brief summary of the procedure will show some problems encountered in using this technique. The required steps are:

1. The patient is seated facing a stand on which the 15 degree angle board rests.

2. He bends forward and turns the head to one side resting his face on the surface of the apparatus with the earplug in the external auditory meatus.

3. The nose is aligned with the end aligning rod and the sagittal plane guide is adjusted for height and angle. These readings are recorded.

4. The x-ray tube is brought into position and aligned with both rods.

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5. The cassette is slipped into the tunnel, and the first exposure is made (usually in the closed position).

6. The cassette is pushed along the tunnel and the next (open) exposure made.

7. The x-ray tube is raised, the earplug is moved to position for the other side, and the cassette is turned 180 degrees.

8. Steps 2 through 7 are repeated for the opposite side of the head.

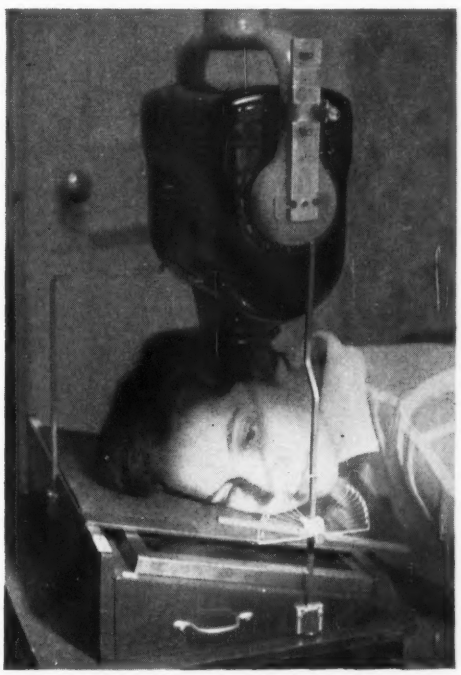

Fig. 1.—The Updegrave procedure showing the relationship of the patient, the cassette holder, and the x-ray tube.

In the Temporomandibular Joint Clinic, the research and teaching clinic of the Division of Clinical Oral Physiology, School of Dental and Oral Surgery, Faculty of Medicine, Columbia University,[3] where hundreds of patients have been examined, the Updegrave apparatus has been used routinely. Often the Updegrave projection was supplemented by lateral laminography and by base and cerebellar projections.[4] There were clinical conditions, however, in which the use of the Updegrave apparatus was difficult. Patients referred for temporomandibular joint evaluation by the Faulkner Arthritis Clinic of the Columbia-Presbyterian Medical Center, found it difficult, and in some cases impossible, to assume the position required for this technique. It also appeared that patients who complained of limitation of opening often had even greater difficulty in opening when they assumed the position demanded by the Updegrave apparatus. Other shortcomings of this technique which became apparent were:

1. The ear plug could not be seen by the operator. In some instances this resulted in incorrect positioning of the patient, requiring retaking of films.

2. The tube must be aligned by eye for each pair of exposures. This proved to require considerable time and careful manipulation in order to avoid cutting off part of the x-ray beam.

3. The sagittal plane readings are very inexact; moreover, the value of these readings is open to question.

MODIFIED APPARATUS

Work was begun in an effort to modify the Updegrave technique to better serve the needs of the Clinic. After some time, it was decided to redesign the apparatus completely in the hope of developing one which would adapt to the patient, rather than having the patient adapt to the apparatus. Because of the flexibility of the dental x-ray machine, it was felt that this aim could best be realized by mounting the device on the yoke which carries the tube of the x-ray machine itself.

It seemed practical to construct a device in which the target area of the cassette holder and the anode of the x-ray tube would function as points on one long side of a parallelogram which would coincide with the central ray. Supporting bars, parallel to the central ray, could then be used as the other long side of the figure. The support brackets at the tube head and the hangers to carry the cassette holder would make the short sides perpendicular to the floor (Figs. 2 and 3). It should then be possible to locate the temporomandibular joint in the central axis by means of an earplug as in the Updegrave apparatus. According to our calculations, there should then be no variation in the point of exit of the central ray from the patient's head and its impingement on the film plane. The use of an open-backed channel with a clear plastic front would permit the operator to see that the earplug was in proper position and that the face was in proper contact with the plastic (Fig. 4).

The dimensions were dictated by the size of the 8″ x 10″ cassette, and were almost identical with the apparatus previously used. Lead marker letters were affixed to the face of the cassette and simple markings on the back of the cassette and holder were provided to tell the operator which view was to be exposed in each position of the cassette (Fig. 5). The brackets for mounting the device to the x-ray machine were designed so that the lower half of each bracket could be mounted on the yoke which carries the tube head. The upper half of each bracket carries the supporting arm. The two halves are easily assembled and disassembled. There is provision for changing the angle formed by the bracket and supporting arm through a considerable arc.

A sliding yoke which rides on the supporting arms carries hanger pieces which in turn support the cassette holder. These pieces are pivoted at both ends, and the distance between the centers of the pivots must be the same as the distance from the tube support pivots of the x-ray machine to the support arm pivots of the mounting brackets. The cassette holder is supported by means of the two lower pivots, which are placed directly in horizontal line with the point of impingement of the central ray on the film plane. The cassette holder consists of

a rectangular aluminum frame in which the cassette travels. The front of this frame carries a Lucite plate which has been drilled and tapped for the earplug exactly as in the Updegrave apparatus. A lead rubber blanket with a 3″ aperture covers the plastic. A line drawn between the lower pivot points and passing through the point of impingement of the central ray and the centers of the two

Fig. 2.—The relationship of the patient, the cassette holder, and the x-ray tube in the simplified technique set-up.

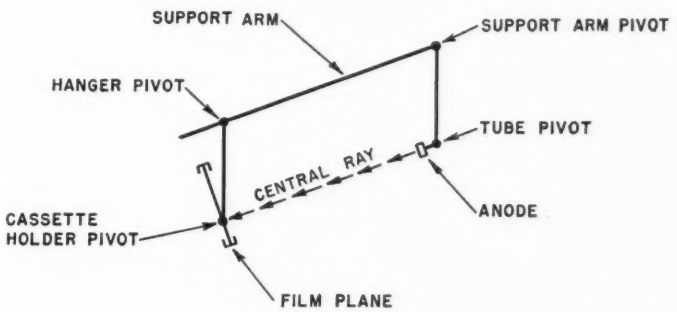

Fig. 3.—Diagram of the simplified apparatus.

holes for the earplug is used to align the patient's face so that the ala-tragus line coincides with this mark (Fig. 6). The position of the earplug and the contact of the face with the plastic are checked through the transparent back of the holder before inserting the cassette (Fig. 4).

A method of correcting the balance mechanism of the x-ray machine for the weight of the new apparatus was devised by Mr. Henry Holman of X-ray Manufacturing Company. A long pivot pin was inserted at the outboard end of the main support arm (Fig. 7). A pair of lead weights equal to the weight of the apparatus with the cassette in it are fastened in place on this pin only *when the apparatus is not in use* (Fig. 8). The cam and counterbalance springs of the x-ray machine are adjusted to handle the additional weight.

Fig. 4.

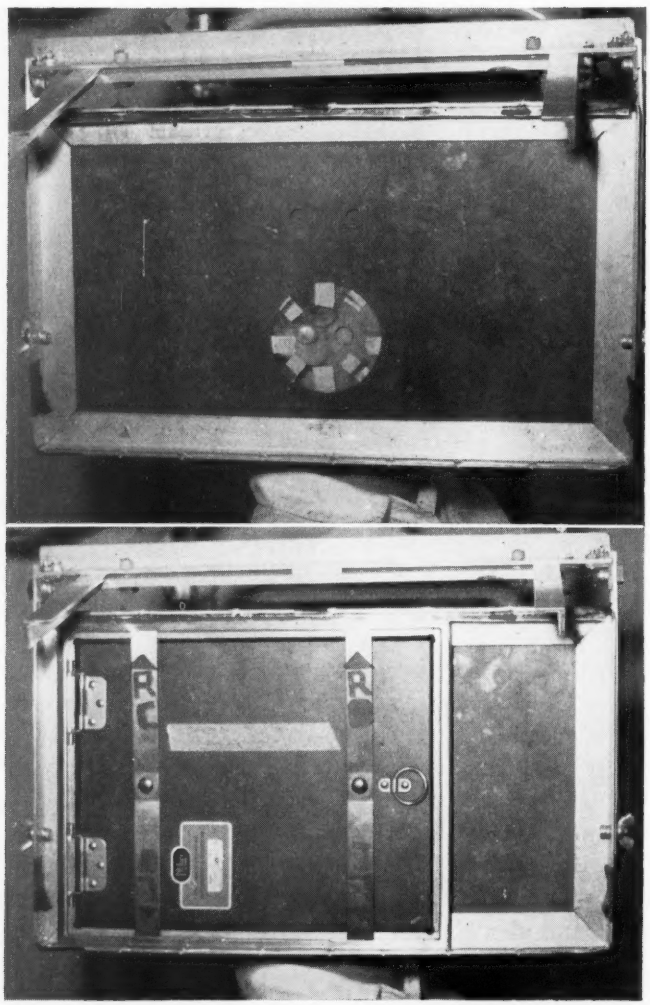

Fig. 5.

Fig. 4.—A view through the transparent area in the cassette holder with the ear plug in position and the face contact checked.

Fig. 5.—The cassette in position. Note the markings indicating the view to be exposed.

EXPOSURE TECHNIQUE

The technique for exposure is similar to that for the apparatus designed by Updegrave. The patient is seated in an upright position, however, and the cassette

holder is brought alongside the head and aligned so that the earplug enters the external auditory meatus. The x-ray tube head is then adjusted to the same angle as the supporting bars, and the alignment of the ala-tragus line and contact of

Fig. 6.

Fig. 7.

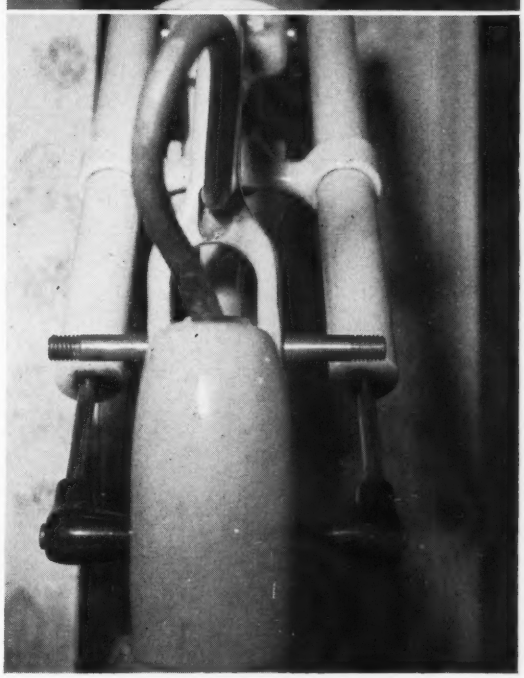

Fig. 6.—The apparatus from the tube side showing the method of checking ala-tragus alignment.

Fig. 7.—The long pivot pin to carry compensating weights which are required only when the temporomandibular joint apparatus is not in use.

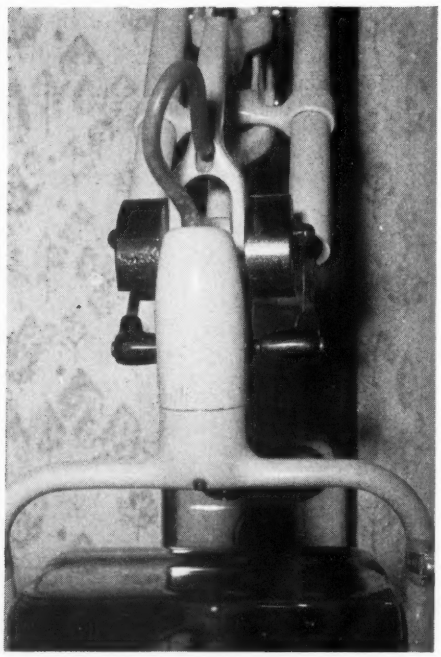

Fig. 8.—The compensating weights are fastened in place.

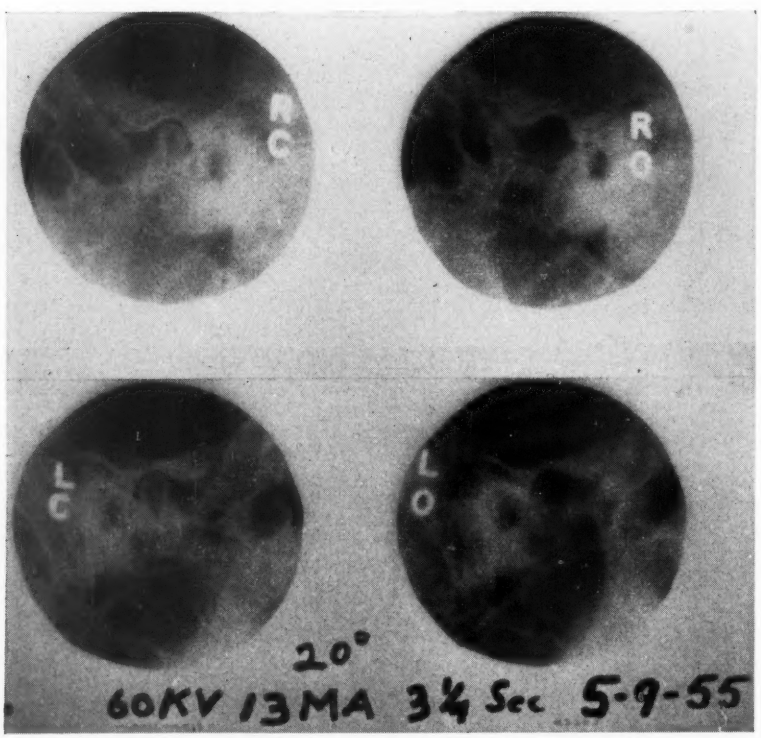

Fig. 9.—Roentgenograms made with this apparatus.

the face with the surface of the cassette holder are checked (Figs. 4 and 6). The cassette containing the film and detail screens is placed in the holder, and the first exposure is made using the guide letters on the back of the cassette as a check that the correct view is being exposed (Fig. 5). The exposure used at the present is 60 kv. Ma., with time ranging from 3 to 4 seconds depending upon the patient.

SUMMARY

The roentgenograms obtained with this device (Fig. 9) have been similar to those obtained with the Updegrave apparatus. The advantages observed are:

1. The upright position of the patient.
2. The prefocused simplicity of alignment of the tube head and cassette.
3. The ease and accuracy of positioning because the earplug can be seen in position.
4. The use of a marking system which informs the operator of the exposure to be made in each position of the cassette.
5. The fact that the device can be used either with the patient in the dental chair, or on any sort of stool or chair depending on the location of the machine and the space available.
6. The short time required to go through the procedure including setting up and taking down the apparatus.

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REPORT OF THE COMMITTEE ON SCIENTIFIC INVESTIGATION AMERICAN ACADEMY OF RESTORATIVE DENTISTRY

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THERE IS A STEADY ACCUMULATION of knowledge, and a tremendous expansion in the volume of publication making it impossible for one in practice to keep up with the advancements in dentistry. Therefore, it helps to have a condensed report by a committee delegated to some research on recent developments, abstracting the material to coincide with a specialized interest.

In the early stages of the development of our profession, diagnosis and treatment, even surgical treatment, were considered to be entirely within the realm of the mechanical arts. Knowledge was accumulated by clinical experience, and individual practitioners spread that knowledge among their confreres by personal communication and by limited publication.

Most of us remember when research was being done by relatively few scientists associated with universities, and perhaps a few more associated with basic industries. Today, research includes a wide range of interests; it runs the gamut from "atomic fission" to "sales possibilities in infant underwear in the year 1965."

Today, scientific knowledge through research in many directions convinces us that we must make the attempt to keep abreast of investigation in other fields besides the strictly dental field.

The expansion of research in industry cannot be overlooked. A Standard Oil official stated recently that industrial research will be a sixteen billion dollar industry itself within twenty years, employing more than one million people. Most of our specialized equipment and many of our materials were outgrowths of industrial research in the last few years. Naturally our techniques and treatments have changed with their adoption.

The government and industry and independent researchers are finding the possibilities in atomic research and electronics to be nothing short of astounding. To mention some of the adaptations in our own field, radio activity may be used to harden plastics, and it may be used for sterilization. Vitamins, hormones, foods, and drugs, generally, are being tagged with isotopes—traceable wherever they go in the human body. The electronic microscope makes it possible to see and isolate

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viruses which the most powerful lens microscope could not accomplish. The electronic principle is used in the design of surgical instruments, vitality testers in dentistry, etc. Apparently, the possibilities in electronic research are beyond the scope of our imagination. Knowledge gained in this way promises dramatic new controls over disease.

It is very gratifying to note the importance and scope of organized research applicable to dentistry which is being conducted today by the profession itself.

Twenty-five years ago what little research there was could not be called organized. A few hardy individuals, dental teachers and practitioners, accomplished what they could, more or less in spare time, without basic training in the field of research. One organization, it is true, had been started ten years or so before that when the International Association for Dental Research was founded by Doctor Gies of the Carnegie Foundation. Its first general meeting was held in 1922. It established a new trend of thought in the halls of dental learning.

This year, the record of the International Association for Dental Research and its accomplishments were reported by Dr. H. Trendley Dean[1] before a congressional committee considering a bill for dental health and research appropriations. The report was impressive, indicating the work and responsibility assumed by dentistry itself to do all it could with means all too limited. It listed thirty-six dental schools reporting 834 papers over a period of five years.

This was a budget hearing. It seems that the budget included an appropriation of $441,000 for dental research. Dr. Dean was suggesting that one million dollars be appropriated instead. I wonder what some of our old pioneers in dental research, Dr. G. V. Black, for example, would think of that. Colonel Dean is secretary of the Council on Dental Research of the American Dental Association.

Nationally, we are represented also by Dr. George C. Paffenbarger, senior research associate of the American Dental Association at the National Bureau of Standards, and by Dr. E. G. Hampp, senior research associate of the American Dental Association at the National Institute of Dental Research, and by Captain J. A. English, head of the dental division of the Naval Medical Research Institute. The trained personnel in these groups working for our interest is considerable.

One suggestion made by Colonel Dean, before the Committee, deserves quotation because of its practical approach to our research problems. "One other item in this budget should be increased, namely the $100,000 amount listed under grants known as research fellowships. As you all know it takes trained research minds to translate research dollars into research findings. It is also well known that the training of the Doctor of Dental Surgery or the Doctor of Medicine is directed largely toward the clinical practice of their profession. There is little in the undergraduate curriculum of either profession that prepares him for a career in the ever increasing complexities of modern research. Hence, it is essential that the young graduate interested in research prepare himself in the basic science or sciences of his choice by taking several years of graduate school study. A fellowship program is necessary to encourage a few selected dental students in each school to familiarize themselves with research studies going on in the school. This is a most worthy effort and a sound approach to stimulating young people in the way of research. Because of limited funds, an approved dental school may apply for only two research

fellowships. We would urgently ask that the sum of $100,000 for research fellowships be increased to $250,000 so that the graduate school training can be enlarged and so that part time fellowships may be increased from two to four in each dental school."

Such training in schools of dentistry would develop men within our own ranks who have the talent for research so that our branch of science will have proper representation in the future.

Most of our research at present is concerned with the study and prevention of dental disease. Nevertheless, we must not forget that in the mind of the public, our primary function as a profession is dental therapy. It is our only excuse for being, if one should care to use that expression. The ideal in the healing arts has always been to do everything possible to discover the etiology of disease as well as to prevent its occurrence. However, the history of mankind illustrates the truism that ideals are seldom attainable.

Therefore, dental therapy must be improved in the meantime to a more ideal status taking advantage of the research which will make it possible.

The vagaries of the human race, being what they are, do not allow the full realization of the latest knowledge in the prevention of disease. Human weaknesses will not permit us to live as well as we know how; therefore, good dental treatment will always be in demand. The hope is that standards will continue to rise.

To illustrate the inconsistency of practice versus knowledge, one of our schools of dentistry with a relatively small student body has two of the largest type of "Cola" dispensing machines near the student lounge, which I am sure are used by members of the faculty as well. Not one machine but two of the largest are required to furnish an excess of refined sugar in the diet of the patrons. Certain principles of dental health are emphasized upstairs in the building while they are ignored on the lower level. Even when we know better, it is not always convenient to make use of what we know. Illustrations of our contrary reactions and inconsistencies could be listed indefinitely.

Correlation between research in the laboratory and in the clinic is of the utmost importance if dental therapy is to take advantage of discoveries. In a report on dental research in the Journal of the American College of Dentists, Paffenbarger, English, and Hampp[2] make this statement: "Basically dentistry is concerned with two chronic diseases; dental caries—a breaking down of the hard tooth tissues—and periodontal disturbances—loss of the investing structure of the teeth. The control and prevention of these two diseases in their various forms are dentistry's major concern. There are of course other responsibilities in regard to repair; restorative and corrective procedures such as prosthetics, oral surgery, orthodontics, and pedodontics . . . . In common with many other chronic diseases such as degenerative, mental, metabolic, and neoplastic diseases, dental caries and periodontal disease have been strikingly resistant to preventive measures. Nevertheless, marked advances are being made in the elucidation, etiology, and prevention of dental caries. Research and only research, in the clinic and in the laboratory, and above all a correlation between the two, can provide control measures necessary to minimize or to prevent dental disease. How can the clinical evaluations and the laboratory studies be brought closer together to narrow the gap between opinion

and fact? Perhaps more clinicians who are research-minded and more research workers who are clinically-minded are needed."

STRUCTURE OF THE TEETH

Quoting again from the report on dental research to the American College of Dentists[2]: "The effectiveness of the fluoride ion in preventing dental caries has stimulated additional research on the actual structure of the hard tooth tissues, especially enamel. Current researches on both the organic and inorganic components of teeth are in progress but need considerable impetus because of their basic nature. The same holds for the determination of many physical and chemical constants for the hard tooth tissues.

"The histology, physiology, and pathology of the pulp are being actively investigated in some laboratories. These include the response of the pulp to thermal, mechanical and chemical injury or stimulation. Some of these investigations should be directed toward diagnostic instrumentation which is vitally needed and also toward the development of substances such as cavity lining materials which will stimulate the production of secondary dentin."

Several instances of laboratory work of this nature were reported; one will be mentioned here as an example of the activity in this direction.

Paynter, Nikiforuk, and Wood[3] report on the "Pulp Protective Effect of Silicone Under Silicate Cement Fillings."

"The chemical structure of silicones imparts to them a thermal stability and resistance to many types of reagents to an extent not found in most organic polymers. The ability of these agents to form water repellent surfaces offers theoretical possibilities . . . . Thirty silicone . . . preparations were tested . . . . It was found that a preparation of methyl-silicone resin in methyl methacrylate monomer gave best results." The tests were made in the molar teeth of rats with silicate fillings using unlined fillings as controls.

They reported an inflammatory reaction in each pulp under fillings with no liners. No such reaction was found when the liner was utilized. The liner was a 30 per cent solution of methyl-silicone resin in methyl methacrylate monomer.

James and Schour[4] carried out an experiment on "The Effects of Cavity Preparations and Zinc Oxide and Eugenol Upon the Human Pulp."

Cavities were prepared in forty-seven premolars of orthodontic patients and filled with zinc oxide and eugenol. Eight additional unoperated teeth were obtained from the same group of patients as controls. The teeth were extracted twenty-two minutes to thirty-nine days later. Specimens sacrificed within the first hour showed considerable reaction in the pulp tissue. Specimens sacrificed after two weeks began to assume a normal appearance. Recovery seemed to be complete in the later survival periods. There was concurrently an absence of reparative dentin.

These findings are in contrast to the pulpal reaction under gutta-percha fillings reported previously. Under gutta-percha there was found in the longer survivals a persistent chronic inflammation and formation of reparative dentin.

After these experiments we might ask ourselves these questions: Which therapy is indicated? Shall we use palliative treatment or attempt to stimulate the pulp to insulate itself?

Grossman and Rossman[5] reported on "Correlation of Clinical Diagnosis and Histo-Pathologic Findings in 101 Pulpless Teeth With Areas of Rarefaction."

In this experiment, clinical diagnosis was established through roentgenographic examination, then periapical tissue was examined microscopically by someone with no knowledge of the clinical diagnosis. By this blind test method, 43.7 per cent of the thirty-two cysts were interpreted incorrectly, as well as 27.5 per cent of the sixty-nine granulomas. These results tended to show that cysts are present more often than it is possible to determine by roentgenographic examination alone.

SALIVA AND MOUTH HABITAT

"There must be a fair balance in solubility relationships of the enamel-saliva system. Otherwise, the enamel would be dissolved or calculus would be precipitated. That these conditions occur frequently indicates an imbalance. Here is a far-too-neglected field in dental research that has considerable potential for extending our knowledge of the cause of dental caries, erosion, and some types of periodontal disease."[2]

Research done to date, and clinical experience have brought out very definitely the fact that salivary tests may be important diagnostic aids. Salivary tests may be important in medical practice as well as in dental practice. Blood analysis and urinalysis have become routine in medical practice. The day may come when salivary analysis will be just as important, if not more important. It may be that research in dentistry may point the way. Blood and urine analyses are simple in comparison with analysis of the saliva. The character of saliva may be changed in a moment by emotional reaction alone. Emotional changes influence the function of the glands in a very short time. It is impossible to speak of pickles or of lemons without increasing the flow of the saliva immediately. And everyone has had the experience of "spitting cotton" when thoroughly frightened by something. There is also the classical picture of the chronically ill or senile, where unhygienic mouth conditions exist, plaques cover the teeth, and it is almost impossible to keep them clean even with thorough brushing; the tongue is coated, the breath is fetid, etc. Then we have the opposite and pleasant picture of a young healthy child with a clean mouth and clean teeth, and clean mucous membrane even when the brush is not used at all, or used very inefficiently. Although few definite conclusions have been reached in experiments in research in saliva, the research on saliva and its effect on the flora and fauna of the mouth are proceeding at a greater rate than ever before. Biologists, biochemists, and immunologists are attacking the problem from their own particular viewpoints. It is entirely within the realm of possibility that, someday, the internist in medicine will depend more on salivary tests and salivary analyses than he does today on any single diagnostic aid.

Anders[6] conducted an experiment using a method for measuring the chloride ion concentration of the saliva in a classification of subjects with special regard to caries activity. Two hundred and fifty-one subjects from 3 years and 6 months to 15 years and 2 months old were tested. Eighty cases with extensive, active, rapid decay had a much greater concentration of the chloride ion in the saliva than thirty caries-free subjects had. Moderate groups fell in between. Anders reached the conclusion that a high chloride level in the saliva is apparently associated with

high caries incidence. This is a very interesting supposition and deserves further study.

Some experiments show that there are apparent hormonal relationships involved in the function of the salivary gland. Bixter, Muhler, and Webster[7] made an interesting experiment on rats on the histochemistry of the adrenal cortex following desalivation. Their experiments show that desalivation was accompanied by uterine and testes weight alterations as well as by histologic changes in the adrenal gland. These findings in addition to those of other workers indicate that the salivary glands may have an intimate relationship with the various endocrine glands. Removal of the major salivary glands was accompanied by an increased adrenocardial activity as evidenced by histochemical tests.

Goaz[8] outlined a method for assaying the influence of the saliva on the decalcifying activity of the lactobacillus. Applying this method to patients who were hyperthyroid as well as hypothyroid, and on a 15-year-old boy with delayed adolescence, he came to this conclusion: under certain conditions there was a decrease in the decalcifying activity of the microorganisms and under other conditions there was an increase. Continued study of the factors involved in this approach to the problem is indicated, and may illustrate that the etiology of caries is not entirely oral in origin, but that systemic factors are influential due to their physiologic control of and the psychologic effect on the composition of saliva.

DENTAL CARIES

In a symposium on dental caries control, Mitchell[9] in his article on the "Mechanism of Dental Caries" states: "In the plaque, the 'factory' for the caries process, acid-producing microorganisms elaborate enzymes during their normal metabolic activities, which in turn convert a substrate, sugar, to an attacking agent of an acid nature (such as lactic acid and its precursors) which disintegrates the inorganic material of the tooth. Thus the plaque furnishes the attacking agent and serves to hold it, with some degree of protection from salivary dilution, against a tooth surface.

"In addition, proteolytic bacteria are probably involved in the process. They too release enzymes which may 'lyse' or dissolve the protein or organic portions of the dental tissues. Consideration of such an hypothesis helps to explain how the organic cuticular structures of the enamel surface, the glycoprotein of the inter-rod substance, and the organic matrix of the dentin can be destroyed by the caries process. Also it may be that protein hydrolysis may liberate acids strong enough to affect the inorganic tooth structures.

"Some of the research supporting this theory or combinations of theories includes the following:

"1. Clinical bacteriological studies indicate a relation between *Lacto bacillus acidophilus* and other aciduric bacteria and high incidence of dental caries.

"2. Caries susceptible animals do not develop disease unless they are fed high carbohydrate diets.

"3. Animals raised in a germ-free environment are not susceptible to caries when fed a high carbohydrate diet; but when their counterparts in open laboratories are fed the same diet, in the presence of microorganisms, caries does develop.

"4. Caries susceptible animals which are fed high carbohydrate diets by stomach tube, thus avoiding local contact with the teeth, do not develop caries.

"5. Certain antibiotics prevent dental caries, presumably because of their antibacterial activity.

"Many systemic factors appear to be related to caries susceptibility; however, their collective practical significance at this time is far outweighed by that of the local factors described here. For example, heredity plays a role in caries resistance as demonstrated in rats by Hunt and his co-workers and indicated by studies of families of human beings; however, this is of no great practical importance in the case of the 30,000,000 school children of this country who show some degree of susceptibility approaching 95 per cent."

Wolman[10] made an excellent short report on fluoridization of water supply. He calls his editorial "Fluoridization and Vituperation." "In April, 1955 the control study of fluoridization of a public water supply in Newburg, New York completed its 10th year of continuous application of fluorides. This event invited an opportunity for a detailed stock taking of the effects of this process on the young and adult population of Newburg in comparison with the residents of Kingston, New York. The latter city was selected ten years ago as a control observation center with no provision for fluoridization. The demographic characteristics of the two cities were strikingly similar. The comparative results of this dramatic long term epidemiologic study have been elaborated elsewhere but the salient findings are worth repeating here for the lessons need emphasis and re-emphasis. In brief they are as follows: 1. Water Fluoridization has no demonstrable systemic or developmental effect on children except for significant reductions in tooth decay. 2. The children examined at Newburg show normal blood hemoglobin values and urine analyses. Many of the children have been drinking fluoridated waters all their lives. 3. Over a fifteen year period the infant mortality rates in both cities have shown a comparably continuing downward trend. The decline in the still birth rate is evident in both cities. 4. The number of decayed, missing and filled permanent teeth in the children of from 6 to 10 years of age was 60% lower among the entire Newburg group of children than among the Kingston children. 5. The decayed, missing and filled permanent teeth among the 6 and 7 year old Newburg children who had consumed fluoridated water all their lives was 75% and 68% lower respectively than for comparable Kingston children.

"Aside from these extremely gratifying public health results, the study represents one of the finest demonstrations of cooperative effort between the citizens and public and private agencies that this country has seen. The foresight and care with which the study was designed and executed through the wise direction of the state and local forces are to be commended.

"The recent volume on the same subjects issued under the aegis of the American Association for the Advancement of Science pushes forward our knowledge of the fluoridization of water and its effects, a very considerable step. All the evidence on all fronts is favorable.

"In the face of these mounting orderly and carefully evaluated undertakings how does one account for the electrically charged attacks on this public health effort

in the city councils, the courts, churches and the public forums. The settlement of scientific issues by vituperation in legislative debate and in the court room is not a new phenomenon. The uses of alum and chlorine in water treatment went through the same baptisms of fire half a century ago. Logic, common sense and overwhelming scientific evidence won the day with immeasurable ultimate values to man. To fight for an idea may be repugnant but it is certainly not novel, nor is it novel for a credited scientist to mix fact and fancy, near truth with truth, and emotion, in a brew calculated to confuse rather than to clarify the minds of the public. In the battle for and against fluoridization the best and the worst of scientific debate are exemplified."

A report from Newsweek[11] makes the following statements: "Some 1,120 United States communities, serving more than 22,000,000 people are now drinking artificially fluoridated water. Besides these there are approximately three and one-half million people living in communities where fluoride occurs naturally in correct amounts in the drinking water. Among the major cities with artificial fluoridation are: Philadelphia, Washington, Baltimore, San Francisco, Denver, Louisville, St. Louis, Miami and Milwaukee. Chicago will start its water fluoridation program within a month. Last week the prospect was that New York City, using 1,000,000,000 gallons a day, would be the next metropolis to fluoridate its drinking water."

PERIODONTAL DISEASE

Rosebury[12] in his "Outline of a Theory of Periodontal Disease" says, "It is assumed that the teeth and supporting structures of modern man continue to be built to last a lifetime instead of being doomed ontogenetically to early loss and phylogenetically to extinction. Periodontal disease is regarded as pathologic and as extrinsically induced and potentially preventable. It is postulated that the interrelated complex of phenomena embracing physiologic growth, maturation and aging of the dental apparatus is subject to a range of disturbances whose sequels, varying in rate of development, severity, and reversibility, constitute periodontal disease. Integration of what is known of the physiologic process and its pathologic modifiers may be achieved without oversimplification. This theory does not point to isolated 'causes' of periodontal disease. It suggests that all such diseases proceed through a characteristic mixed infection, apparently qualitatively similar in all clinical types of periodontal disease, but differing in degree and in acuity to inflammation and associated damage. These are looked upon as unifying pathologic phenomena; but infection is clearly not primary, and neither infection nor inflammation, nor 'local' versus 'systemic' agencies, nor the activity of any one tissue, nor any other individual component, can be assigned unique or of preponderating significance. Clinical and pathologic differences among types of periodontal disease are postulated as traceable to different patterns of resistance and response to the characteristic infection."

Rosebury[12] suggests in his "Outline" that factors in the treatment of periodontal disease are the pathologic agencies, such as hormonal upsets, nutritional disturbances, poor hygiene, etc., which may be complicating the normal maturation and aging of the periodontium under which heading he puts such factors as functional stress, premature loss of teeth, decreasing plasticity of bone, etc.

However, he also suggests that "The various forms of periodontal disease all proceed through a characteristic mixed infection which may differ quantitatively, hence in intensity, in relation to combinations of underlying agencies. While infection and inflammation are looked upon as invariable phenomena according to this view, neither is ever primary or causative in any simple sense."[12]

This postulate ties in with experiments conducted by Orban and Bhaskar[13] in their experiments on occlusal trauma in the monkey. Their report is as follows:

"To study the relationship between excessive occlusal forces and periodontal disease, MOD inlays were cemented in the upper first premolars of 4 adult monkeys. These inlays were so constructed that in the centric and the right lateral movements the premolar tooth was subjected to excessive occlusal stress. The monkeys were profused with 10 per cent formalin at 3 days, 3 weeks, 3 months, and 6 months postoperatively, jaws decalcified, and the upper premolar area was sectioned serially in a buccolingual direction and the corresponding region of the lower jaw was sectioned in a mesiodistal direction. The findings were: (1) At 3 days postoperatively the tension as well as the pressure side showed thrombosis of periodontal blood vessels; in addition, the pressure side showed bone necrosis and crushing of connective tissue fibers. (2) At 3 weeks both the pressure and tension sides showed extensive areas of root resorption and on the pressure side there was extensive resorption of bone. (3) Three and 6 month postoperative stages were characterized by complete repair of root surface and alveolar bone. (4) Tearing of periodontal fibers on the tension side was never observed. (5) Periodontal pockets did not develop at any stage."

This experiment of trauma alone on the teeth of monkeys would tend to bear out Rosebury's statement that the typical periodontal disease proceeds through a characteristic mixed infection not found in the experiment on monkeys which may differ quantitatively due to a combination of underlying agencies in the human being.

PAIN CONTROL AND ANESTHESIA

Oman[14] published a very fine logical and concise article recently, on control of pain in operative dentistry.

"The responsibility of the dentist in operative procedures is to use every means at his command to reduce pain and unpleasant sensations so that fear of the dentist may be gradually reduced. The control of pain in operative dentistry does not necessarily mean its total elimination. It does mean that pain may be controlled to a point where the dentist can perform the operation successfully and at the same time leave as few unfavorable impressions in the minds of the patients as possible."

He says that other factors must be considered besides anesthesia of the tissues. Too often, I am afraid, we forget to put ourselves in the patient's place. We are likely to forget the nervousness and the fears which influence his thinking and his state of mind. A good discipline might be for us to sit in the dental chair more frequently ourselves.

The patient's mental attitude starts with the environment of the office and his observation of all factors which might be conducive toward a feeling of relaxation and confidence.

We are too likely to think that the scientific approach requires complicated equipment, and something that would be atomic, or at least electronic. While playing with new gadgets, we may forget some of the fundamentals. Occasionally, it may be well to sit down and relax, close our eyes and try to see ourselves as others see us.

For instance, we know that in order to please the patient we must try to avoid any discomfort, in addition to actual pain. We are inclined to think of the patient's comfort in terms of anesthetics only, or in the use of more efficient instruments in surgery. Many instances of discomfort which the patient thinks of as no small matter might be avoided; he does not recognize some things as mere details of operating. Some of these items are: 1. Careless scaling of the teeth; 2. Forcing ligatures between contact points, and allowing them to traumatize the papillae; 3. Picking up the cold air syringe when we intended to pick up a warm one; 4. Forcing ligatures around the periphery of young teeth; 5. Putting in baseplate gutta-percha when it is too hot; 6. Digging into a sensitive cavity with an explorer when we knew it was there all the time, etc. This list could go on and on.

I am reminded of the late Dr. J. D. White, former teacher and preceptor of mine, some of whose patients I inherited. Dr. White never used local anesthesia, yet his patients used to tell me that when they got into his chair they had a feeling of relaxation, because they felt confident that if there was to be any discomfort whatsoever, it would be absolutely necessary. It may be that the use of anesthetics tends to make us a little careless. Therefore, it would be well if we took stock every once in a while.

Although there have been reports in the literature recently of new anesthetics, local and general, which might be used in dentistry, they are still in the experimental stage. This report will confine itself to some of the latest investigation and thought on local anesthesia with procaine and procaine combinations, because the drugs and the methods of use have reached a high plane of development, and they have stood the tests of time.

Topical applications make the insertion of the needle painless. There are several preparations on the market which are excellent. If the topical applications are made according to directions, and the hypodermic is used skillfully, the profession can argue conclusively that good dental care has eliminated all pain of consequence. Pain of any appreciable extent is caused by lack of skill on the part of the operator, or it has been created by the patient's mental attitude.

It has been known for many years that procaine, in addition to being a local anesthetic agent, is also a rather active vasodilator. Procaine is nontoxic and does not cause local irritation in 2 per cent concentration. But because of its vasodilator activity, additions to the solution are necessary in order to keep the material localized. Epinephrine has been a most popular drug for this purpose. Because epinephrine is a heart stimulant, there has always been some question as to whether or not it should be used in operating on patients with cardiac disability.

There have been so many diverse opinions regarding the unfavorable action of epinephrine when used in connection with procaine for dental and oral surgery procedures that the Council of the New York Institute of Clinical Oral Pathology[15] decided to get an authoritative opinion which could be used as a guide by the

dental practitioner in the care of patients who suffer from diseases of the heart and the circulatory system. The New York Heart Association, Inc., appointed a special committee to study the use of epinephrine in connection with procaine in dental procedures. Later, this committee submitted the following report:

"1. It is our understanding of common dental practice that epinephrine is used in dilutions of 1:50,000 and occasionally 1:100,000; never more concentrated than 1:50,000. Rarely more than 2.0 cc. of solution are used in any one session.

"2. Epinephrine is combined with a local anesthetic, commonly procaine. One of the pharmacologic actions of procaine is to counteract the tendency of epinephrine to cause cardiac irregularities.

"3. The dentist should have information from the physician about the nature and severity of the heart disease in the patient. He should also have knowledge of the medication the patient is receiving, particularly such medication as might increase the activity of the epinephrine. This knowledge is important because ordinary dental procedures may produce some emotional stress and cause cardiac disturbance which might be wrongly attributed to epinephrine.

"4. Under these conditions and with these precautions, the use of epinephrine with procaine for dental surgery presents no special hazards in persons with heart disease. We would recommend for any one session that there be used no more than 10.0 cc. of 1:50,000 epinephrine—no more than 0.2 mgm. of epinephrine in any form.

"The policy and budget committee of the New York Heart Association has given approval to the publication of the report which the Council of the New York Institute of Clinical Oral Pathology considered so important that it deserved wide publicity."

We will name three improved solutions for local anesthesia of the procaine type which are giving excellent results. They are: 1. Xylocaine by Astra. 2. Ravocaine by Cooke-Waite. 3. Primocaine by Novocol. Xylocaine led off some years ago, and was such an improvement over what we had been using that possibly other manufacturers were stimulated to follow the lead.

The manufacturers of Xylocaine call their main ingredient "Lidocaine Hydrochlorid," and of Ravocaine call theirs "Propoxytaine Hydrochlorid,"[16] and of Primocaine call theirs "Primocaine Hydrochlorid."[17] As you know, the present style of promotion for pharmaceuticals is to patent a name and to patent a drug combination. However, there is a sincere effort these days on the part of the pharmaceutical houses to put their preparations on trial and subject to experiment and research before they are put on the market. This was done in the case of all three of the above-named preparations and they can be recommended.

THERAPEUTICS

Under the heading of therapeutics, this report will be limited to a report on antienzymes or enzyme inhibitors and stannous fluorides in dentifrices.

Since Fosdick[18] has done much original work on enzyme inhibitors, we will refer to his work or to actual statements made by him as recently as October, 1955.

"During the past decade, knowledge of enzymes with respect to living processes has had an amazing growth. It is now known that most of the living processes are governed by enzymes, and it is known that many of the vitamins, hormones and drugs for the combatting of disease act by virtue of their effects as co-enzymes or their accelerating or their inhibitory effects on enzymes.

"According to the chemicoparasitic theory of dental caries, this disease is intimately associated with the enzymatic degradation of carbohydrate on the tooth surface to lactic and other acids." Thus, the theory that enzyme inhibitors may be used for the control of dental caries seems most attractive.

"A review of the fundamental conditions under which an enzyme inhibitor should be effective in the control of dental caries may reveal why this method of caries control has not been very successful. There are two primary requisites for the effective applications of the theory:

"1. The inhibitor must prevent fermentation to lactic acid. This may be accomplished by inactivating one or more of the glycolytic enzymes, or by interfering with the normal metabolic process of the acidogenic micro-organisms.

"2. The inhibitor must be at the site of acid formation at the time the substrate or sugar is present . . . .

"With the foregoing considerations in mind, just what has been done in the prevention of dental caries by means of enzyme inhibitors? There are two logical procedures that may be attempted. The inhibitor may be placed in the mouth by means of a dentifrice, mouthwash, chewing gum or lozenge or it may be incorporated in sugar or confections. To date the first method seems to be the more popular. With this method, however, it is extremely difficult, if not impossible to fulfill completely the second requirement.

"Most dentifrices contain substances that effectively block acid formation in vitro. In fact, the old soap chalk dentifrice was successful in this regard, but few people would claim any anticariogenic effects for this type of dentifrice aside from the normal effects of good oral hygiene. It was not until 1953, that the mechanism for the retention of the enzyme inhibitor in situ for long periods of time was suggested. It was proposed that if inhibitors could be found which would attach themselves to the dental plaque by absorption, adsorption, or chemical combinations and then remain active in situ, a dentifrice for the control of caries might be possible. Under these conditions the active ingredient would become attached to that portion of the dental plaque that remains after the teeth are brushed, which by coincidence is, in the main, that under which dental caries normally occurs.

"Unfortunately, experiments on the use of enzyme inhibitors for the control of dental caries in human beings are comparatively few . . . . Unfortunately, none of the results, with the exception of those on the low ammonium-urea combination, have been checked by two independent observers. Furthermore, only the high urea-ammonium combination, sodium N-lauroyl sarcosinate, and sodium dehydroacetate-sodium oxalate combination are available to the public generally.

"In summary, it can be stated that, from a theoretical point of view, the use of enzyme inhibitors is very attractive. From a practical point of view there are many factors that make the application of the theory extremely difficult. In animal

experiments, at least 10 enzyme inhibitors have been used successfully in the control of dental caries. In human experiments, penicillin, high urea-ammonium combinations, sodium N-lauroyl sarcosinate, sodium dehydroacetate, sodium oxalate combinations and tyrothricin have been successfully used in dentifrices with statistically significant results. Of these, only three are generally available to the public. . . . Thus, it would seem that enzyme inhibitors may be used for the control of dental caries, and as knowledge increases, new applications in dentistry may be expected just as in the other biological sciences."

Muhler, Radike, Nebergall, and Day[19] made a report on "A Comparison Between the Anticariogenic Effects of Dentifrices Containing Stannous Fluoride and Sodium Fluoride."

"It is well established that sodium fluoride added to a fluorine-deficient water supply or applied topically to the erupted teeth of children will reduce the incidence of dental caries. In an attempt to find fluoride compounds with greater anticariogenicity than sodium fluoride, a considerable amount of experimental work has been undertaken. Numerous studies involving a variety of different experimental technics have all indicated the superiority of the tin fluorides over sodium fluoride. These include solubility reduction tests on powdered dental enamel and intact enamel surfaces, experimental dental caries studies in rats and hamsters, as well as human clinical topical studies. In addition, it has been reported recently that with both children and adults, stannous fluoride is effective in reducing the incidence of dental caries when placed in a dentifrice in which the abrasive is a heat-treated calcium phosphate.

"It thus became of interest to determine whether the use of a dentifrice containing sodium fluoride and one containing stannous fluoride would result in similar reductions in dental caries in children."

The experiment was conducted on 854 grade school children in the Bloomington, Indiana, area.

Stannous fluoride-containing dentifrice contained one thousand parts per million fluorine as stannous fluoride. The sodium fluoride dentifrice contained one thousand parts per million fluorine as sodium fluoride, and the controlled dentifrice contained no added fluoride of any kind. Time will not permit further details as to how the experiment was conducted, but it seemed to have been conducted in a very scientific manner and with adequate controls.

The report was summarized as follows: "A clinical dental caries test has been conducted for a period of one year for the purpose of comparing the anticariogenic effects of sodium fluoride and stannous fluoride in a paste-type dentifrice when used by grade school children in accordance with their usual tooth brushing habits.

"The stannous fluoride-containing dentifrice caused a significant reduction in dental caries while the sodium fluoride-containing dentifrice had no significant effect."

RESTORATIVE DENTISTRY

It would be a waste of time to try to describe in a few words the scientific investigation on this subject when the two-day program of the American Academy of Restorative Dentistry given each year is the most complete report.

We spend two whole days of concentrated effort with our essay program and our clinic program, hearing the latest thought and seeing the most recent practical results achieved with materials, equipment, and techniques demonstrated by experts. Our aim in restorative dentistry is to try to achieve normal function of the entire dental mechanism through the medium of biomechanics. Therefore, restorative dentistry creates a primary interest in materials and equipment, and the techniques associated with their use, in order to achieve a final result in treatment in keeping with our knowledge of the basic science of dentistry.

The essay program and the clinic program constitute the best report on scientific investigation in restorative dentistry you could get anywhere. It has been said by many that our programs are two years in advance of contemporary thought. That may be an understatement.

Some materials used in restoration are being improved, and some are being shelved until they can come up to a proper standard.

Accurate casting is no longer a problem.

Impression materials are excellent when they are used precisely with an accurate technique.

The design of operating equipment for tooth preparation is in a state of flux. We had the slow speed dental engine, then the Air-Dent, then high speed engines and handpieces, and now the Cavitron and higher speed operating equipment. Along with the high speeds, we require equipment for cooling and equipment for clearing the field of coolants and abrasives.

That brings us back to the rubber dam if we were ever foolish enough to discard it. So you see history repeats itself!

This report will close with a quotation made by William Harvey, in 1628, in his treatise report to the Royal College of Surgeons on Circulation of the Blood.

He wanted those present to accept his report for what it was worth and the quotation from an old Greek play ran thus:

> "For never yet hath anyone attained
> To such perfection, but that time, and place,
> And use, have brought addition to his knowledge;
> Or made correction, or admonished him,
> That he was ignorant of much which he
> Had thought he knew; or led him to reject
> What he had once esteemed of highest price."

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1202 Missouri Theater Bldg.

St. Louis 3, Mo.

THE MALE OFFICE MANAGER-TECHNICIAN IN THE DENTAL OFFICE

GEORGE E. O'BRIEN, B.A., D.D.S., AND JOHN C. BRUTTING,
Office Manager-Technician

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FROM THE DENTIST'S POINT OF VIEW

THE DEVELOPMENT OF A suburban dental practice with proper attention to the prosthodontic needs of a community presents an interesting challenge and some unique problems for the dentist beginning such a practice.

Circumstances of time and distance from commercial laboratories make it far easier for the dentist to accept the appliances fabricated by the technician without adequate written instructions, than to give such detailed instructions that careful prosthodontics requires, and to have them properly carried out. Many suburban dentists have concluded, for this and other reasons, that mouth reconstruction procedures can be carried out successfully only in larger cities. The dentist then turns his major attentions to work which he can perform in the office without laboratory assistance, or performs only the most routine prosthodontic procedures in a manner which requires the very least deviation from set procedures on the part of the technician. Thus is born the expression, "That's certainly very interesting, but I'm too busy to do that sort of thing (prosthetic dentistry)."

In spite of these difficulties, the problem can be solved, by the suburban dentist, by the use of the very adequate by-mail service provided by some excellent commercial laboratories. He can take the time to write or telephone, in proper detail, the necessary instructions, and these will be followed carefully by the technician assigned to his work. Essential to such a system, however, is adequate and steady office assistance—a chair-assistant office-girl who is sufficiently trained in laboratory procedures to do some preliminary preparation, before packing and mailing the material to the laboratory. Here the problem becomes discouraging to all but the most persistent or fortunate dentists. They soon become well acquainted with the inexperienced girl who "always wanted to work in a dental office," who is usually starry-eyed, and soon is appalled to find that the work is hard. Dentists find that for a great variety of reasons, most girls turn out to be temporary employees, and that the experienced girl is a rare item. Even the experienced girl is rarely income-producing unless she is a graduate hygienist or a laboratory technician. So the dream of building prosthodontics into one's suburban dental practice is often thwarted by the ever-changing office girl.

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ESSENTIALS OF SUBURBAN PRACTICE

There are at least three essentials to the development of a suburban dental practice with attention to prosthodontic needs. Continuous, formal postgraduate study of a general nature; the practice of patient education; and adequate and steady auxiliary office assistance are basic requirements. Of these, this article is concerned with the last, for the problem as stated, can be most easily and satisfactorily solved in all of its aspects by the employment of a male dental technician who can and will be trained to be office manager.

DUTIES OF THE OFFICE MANAGER-TECHNICIAN

The duties and responsibilities of the male office manager-technician would be in three categories. 1. *Managerial:* These activities include responsibility for the telephone, appointment book, clerical work, purchasing, equipment care, and office appearance. 2. *Chair Assistant:* This duty would be required only occasionally. 3. *Laboratory Technician:* His major task would be for the usual laboratory services. This work would be in balance with, but never to the exclusion of the other duties.

An efficient system of office management should exist if the office manager is to spend a minimum amount of time in this aspect of his work. He cannot be expected to evolve the system himself. The study of a proved system of office management will help.

The use of the many mechanical, chair-side, time-saving devices as will allow the dentist to perform his work without human assistance, except in occasional, unusual circumstances, will minimize the number of interruptions in the work of the technician. Tongue and cheek retractors, high-speed, water-cooled rotary instruments, an amalgamator, and efficient saliva ejectors are examples. A knowledge of and preplanned procedural use of these instruments, as well as the more recently developed impression materials and techniques will save time for both technician and dentist, and increase the productivity of the office. With their increased use, the dentist will find little need to call the technician from his other duties in order to assist at the chair.

The laboratory should be so placed, designed, and equipped that the technician can do effective work in a minimum amount of time. In short, his working conditions should be at least as pleasant as those of the dentist. A man who accepts such a job has thrown his trust, his hopes, and the future of himself and his family with dentistry and with the dentist with whom he will work. Ultimate success depends, to no small degree, upon the dentist's awareness of his needs. In addition to pleasant working conditions, there must exist, from the beginning of his employment, adequate working capital funds to assure the weekly pay check on time, regardless of collections at that particular time. From the beginning, the rate of pay must compare favorably with that of local industry. In spite of the irregular hours often required of the dentist, every effort should be made to provide regular working hours for the office manager-technician.

Continuing training of the office manager-technician is of utmost importance, if his interest in the work is to remain at a high level. A man cannot be expected

to be a completely trained technician, in all aspects of the work, unless the practice has been long established, and unless he is a man of wide experience, deliberately sought, and his salary requirements understood and anticipated. A definite teaching program on a set schedule of time which will not be interrupted should be set up. During these periods, the technician's training can be continued along conventional lines, procedures already understood can be refined, and new procedures tried. The technician and the dentist must be willing to spend this additional time working together for as long as is required to work out the basic procedures to the satisfaction of both. This will fill in the gaps in the technician's training, and will justify a steady increase in pay for him.

QUALIFICATIONS

The office manager-technician should be a man of better than average appearance, vocal expression, and manners, and should have some training and experience in at least one aspect of dental laboratory work. Innate intelligence and willingness to learn must exist already in such a man. This means that an exceptional man must be found. The laboratory technician field is full of exceptional men. The armed services picked from the ranks only the exceptional men for training as medical and dental corpsmen and technicians. Too often these men have been discouraged by the limited opportunities for well-rounded training in the commercial laboratories, and they have been misled by the glowing promises held out by some dental technician "schools" of doubtful reputation. A superficial search will reveal men looking for such an opportunity as the position of office manager-technician can provide them.

If fundamental requirements of employer-employee relationships are observed, the result will be one of mutual benefit and satisfaction,—and indeed it must be if the practice is to survive and prosper. The most immediate benefit which will accrue to the office will be economic. The office manager will prove to be income producing at once. This will be at least to the extent that he produces the difference between his own salary and that of the nonincome-producing office girl who would ordinarily be employed. In a short time he will pay his own salary and begin to earn income for the office.

Simultaneously, it will become apparent to the dentist that he is more completely in charge of his own practice, and of the carrying out of his prosthetic prescription than he has ever been before. Extraneous influences which should never play a part in dental diagnosis and treatment planning are removed, and the practice of prosthetic dentistry becomes a joy instead of a series of minor annoyances. Many of the newer materials can be used to advantage. A more complete comprehension of the laboratory problems brings alterations and refinements to chairside operations. Better dentistry is sure to result.

REACTION OF PATIENTS

Complete acceptance by both men and women patients will be automatic and usually without comment. The most frequent observation (when solicited) will be that the office has a down-to-business atmosphere which is conveyed by two

men going about the important business of dental care in a serious manner. Many dentists who read this will summarily reject the whole idea of a male individual in the role of receptionist and chair assistant. Their reasoning will lead them to the argument, "You can't do that in my town. The people would object to having a man answer the telephone and assisting at the chair. They are used to having a girl around those things, especially the women patients." The fact is that in five years of experience, during which we have actively sought criticism from time to time, we have been unable to elicit anything except favorable comment, and we have never found a woman who would prefer to talk to another woman than to a man. These people are no different than those in any other locality. For those dentists who, as a result of an unshakable, preconceived picture of the office girl in the dental office, cannot bring themselves to shut her out, there is encouraging news that as the practice grows, part time then full time assistance at clerical and chair-side aspects can be employed—but always under the managerial supervision of the office manager-technician.

When an office girl is employed by the dentist to give relief to the technician from some of his duties, she may be turned over to the office manager who will teach her only the most routine procedures of the office. She will be considered a temporary employee, and her training is limited accordingly until it appears to everyone's satisfaction, hers included, that she might warrant further instruction with a view to accepting a full time job. In the search for such a girl, the usual considerations such as marriage, mutual disagreement, lack of interest in the work, etc., will arise, but the office will not be seriously upset if she leaves. The dentist will be left virtually unruffled by her departure and the introduction of a new girl into the office routine. Except for the interview by the dentist, all will be handled by the office manager. He soon develops training techniques which consume as little of his time with each new girl as is necessary.

LENGTH OF SERVICE

It has been argued that the ambitious technician has in mind primarily the accumulation of enough "know-how" and finances to start his own laboratory. This is one of the great privileges which exists more freely in this country than anywhere in the world, and is certainly part of the thinking of any reasonable technician when he considers what his future will be. If he is the right kind of man, he will be constantly seeking to better himself and his family. He will be looking about him at every turn for a better job and more pay than the one he has. While that will be a force drawing him away from your employ, it is also the force which leads him to constant self improvement in the technical field. As a result, he will be doing a better job for you. He can and will leave your office eventually unless the opportunities, salary, and working conditions offered to him are sufficient to compete with outside influences. If you have had a satisfactory arrangement with the office manager-technician plan over a period of years, and he chooses to seek what may be greener pastures for himself, the office as well as the technician can only have gained as a result of the experience. If one refuses to consider the plan because it might some day come to an end, nothing can be gained. The chances are, among other things, that you will have acquired,

and he will have trained, at least one girl employee who can fill the gap for you while another technician is sought. But there are strong forces which grow with the years which will tend to discourage the abandonment of the satisfactory office manager-technician position. As times passes, the organization grows and with it the managerial responsibilities. With each new employee acquired, the future of the office manager becomes more secure—the full time office girl, the laboratory assistant, the hygienist—each will require managerial supervision, and the office manager's value, prestige, and experience increase. By remaining with such a growing, successful office he can expect eventually to draw from it a premium salary and to be worth to the office every bit of the pay he receives.

THE OFFICE MANAGER-TECHNICIAN'S POINT OF VIEW

The method of operation of the modern dental laboratory tends to emphasize the system of specialization. There are many technicians working under one roof, each specializing in one phase of prosthetic dentistry, and very often they know little more than the one phase at which they work day after day. There usually is little time or opportunity for a technician to learn other than the phase of laboratory work at which he works. Thus, today, many technicians find that they are specialists. As a specialist, (plaster man, waxer, packer, polisher, set-up man, etc.) his task is the same day after day, and soon it becomes monotonous and very discouraging. The lack of opportunities to learn, and to eventually better their financial station, cause many men to leave the commercial laboratory for other fields. For the technician who has run into this "dead end," the position of office manager and technician offers unlimited opportunities; the opportunity to learn, to receive a better salary eventually, and to have excellent working conditions.

The man who accepts such a position should have a few basic qualifications besides being a technician. He should have a true desire to learn all he can about his chosen field. He must be neat and careful of his appearance, as he will be in constant contact with the public. He should have a pleasant speaking voice, as very often the first impressions formed by prospective patients over the telephone determine whether or not they become patients. He must be polite and courteous at all times. There is much for the technician to learn about the operation of the business office. The dentist will instruct him in the ways he wishes his office work to be handled. A carefully worked out office system will help greatly to keep the office work to a minimum, thus allowing the technician more bench time. By learning to manage the office well, the office girl or assistant can be eliminated at first. Thus, the office can afford to pay him a fair salary. Some of the duties involved with the managerial position are purchasing of supplies, making appointments for the patients, answering the telephone, the care of the equipment, and the care for the appearance of the office, and of course, the clerical work. With a carefully worked out office system, most of this can be done in a couple of hours a day leaving the remainder of the day for laboratory work. At first, the office must continue to send out a portion of its laboratory work to the commercial laboratory. After a period of time, as the technician learns new phases of his trade, almost all of the prosthetic work will be completed in the office laboratory.

The same as when the technician worked in the commercial laboratory, there is little time during office hours to learn new techniques, so he should plan on spending extra time learning. Since the dentist must teach the technician, a good arrangement is to set aside one night each week which is convenient to both. At these evening sessions, the dentist will have the time to explain in detail the way he wishes his prosthetic work done. Clinics that are held by various manufacturers also offer a fine source of continuing education. As you can see, such a position is only for a man who firmly desires to become a good all around technician and is willing to work at learning. He should realize at the very beginning that it will take him years to become a good technician, and also that the growth of his salary depends upon his ability to do many types of laboratory procedures along with the growth of the dentist's practice. Many times he will become discouraged and reason that he can do better financially elsewhere, but the pleasant working conditions, and the knowledge that he is learning and that, if he is patient, he will have a financially good future are well worth working for.

OFFICE SCHEDULE

A technician working under such an arrangement, where he will have many interruptions (telephone, assisting the dentist at the chair, welcoming patients, arranging appointments, etc.) must learn to estimate the length of time needed to complete each job so that he can accurately arrange the patient's next appointment. A typical day's schedule for the office manager-technician might be:

8:00- 9:00 A.M.	Prepare the operating room for the morning patients, do the clerical work, and make the necessary phone calls.
9:00-12:30	Laboratory time.
12:30- 1:30	(Dentist's lunch hour) The technician prepares the operating office for afternoon patients, replaces instruments, sweeps entire office, and straightens waiting room. The remainder of the time is used for laboratory work.
1:30- 2:30	(Technician's lunch hour) The dentist and technician have separate lunch hours so that the office phone is always covered.
2:30- 4:30	Laboratory time.
4:30- 5:00	Develop roentgenograms, prepare charts for the next day's work, and make the necessary phone calls.

One criticism of the office manager and technician position will be that the technician depends totally upon the dentist for employment. What happens if the dentist is struck by a truck, or ill health forces him to retire? A well-trained technician will have many choices should such a problem arise. He can go into business if he has accumulated enough knowledge of his trade to assure his success. He would be wanted by other dentists, usually a dentist nearby who has

seen the success of this arrangement, or if he desired, he could look for employment with a commercial laboratory where he could expect a premium salary.

There is a great sense of satisfaction to a man working for a dentist. A denture, a bridge, a crown, is no longer just a number on a work sheet. He knows the patient for whom the work has been done. He receives a fine feeling of satisfaction knowing the patients are happy with their work, and that he has had an active part in that dentistry. In past years, a technician was limited to seek employment with either a commercial laboratory or a dentist with a well-established practice. With the position of office manager and technician, a man can build a career for himself with a dentist who is in the process of establishing himself in the community. A dentist no longer need be in practice for years before he can avail himself of the services of an office technician. The services of a well-trained technician will always be needed by the dental profession, and there certainly is no greater opportunity for a man to learn many aspects of his trade than to work directly with the dentist.

SUMMARY

A plan of dental office organization has been described by which a suburban dentist may afford the services of his own technician as his prosthodontic practice grows. This plan of organization makes it possible for the serious-minded technician to increase his value to the dentist he works for and to the dental profession.

172 Washington Ave.
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Special Announcement

NOW AVAILABLE

Reprints of THE GLOSSARY OF PROSTHODONTIC TERMS, bound in heavy paper covers.

THE GLOSSARY OF PROSTHODONTIC TERMS by The Academy of Denture Prosthetics, as edited by The Nomenclature Committee of the Academy: Carl O. Boucher, D.D.S., Chairman; Richard H. Kingery, D.D.S., LeRoy E. Kurth, D.D.S., Victor H. Sears, D.D.S., Vincent R. Trapozzano, D.D.S., and Jack Werner, D.D.S., was published in the JOURNAL OF PROSTHETIC DENTISTRY, Vol. 6, No. 2 (March), 1956. It is the result of three years' effort on the part of the Nomenclature Committee and members of The Academy of Denture Prosthetics. The Glossary consists of 34 pages and contains over 800 terms and definitions. It represents the most modern concepts of the terms used in prosthodontic literature by the majority of the members of the Academy of Denture Prosthetics. It is a useful and valuable reference.

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News and Notes

ANNOUNCEMENTS

A two day meeting of The Greater New York Academy of Prosthodontics will be held at Bard Hall, Columbia University, New York, N.Y., on Saturday, Dec. 1, and Sunday, Dec. 2, 1956. Essays will be presented on the following subjects: Gold and porcelain restorations, occlusal rehabilitation, fixed and removable partial dentures, complete dentures and related problems.

The Rowe Smith Memorial Foundation will hold its Third Annual Seminar at Fly-n-Fish Lodge, Caddo Lake, Karnack, Texas, Dec. 2 to 5, 1956. For further information, write to Rowe Smith Memorial Foundation, 501 State National Bank Bldg., Texarkana, Ark.

The Greater New York Dental Meeting will be held Dec. 3 to 7, 1956, at the Hotel Statler in New York City.

The next meeting of the American Denture Society will be held at the Congress Hotel, Chicago, Feb. 2 and 3, 1957.

The annual meeting of the American Academy of Restorative Dentistry will be held at the Conrad Hilton Hotel in Chicago, Feb. 2 and 3, 1957.

The annual meeting of the American Academy of Crown and Bridge Prosthodontics will be held at the Conrad Hilton Hotel, Chicago, Ill., Feb. 2 and 3, 1957.

The 15th Annual Meeting of the American Association for Cleft Palate Rehabilitation will be held on May 2, 3, and 4, 1957, at the Hotel Cleveland, Cleveland, Ohio.

For further information, please write to McKenzie W. Buck, Speech and Hearing Clinic, University of Florida, Gainesville, Fla.

Doctor O. M. Dresen, Dean of the School of Dentistry, Marquette University, has been elected Honorary President of the American Board of Prosthodontics. This was done in recognition of his long service to the Board from its inception to the present time.

The Medical College of Virginia, School of Dentistry, announces a series of postgraduate courses of interest to general practitioners. These courses are given by the members of the faculty, unless otherwise designated.

Complete Denture Construction, Vincent R. Trapozzano	Jan. 14-19, 1957
Partial Denture Design, Vincent R. Trapozzano	Jan. 21-26, 1957
Crown and Bridge Prosthesis	Feb. 18-20, 1957
Oral Diagnosis	March 11-15, 1957
Anatomy of the Head and Neck	March 18-22, 1957
Oral Surgery	April 1-3, 1957
Roentgenology	April 8-10, 1957

For further information, write to H. T. Knighton, Director of Postgraduate and Graduate Instruction, Medical College of Virginia, School of Dentistry, Richmond 19, Va.

Temple University School of Dentistry announces the following postgraduate courses for the 1956-57 session:

Full Denture Prosthesis, Dr. Bernard Jankelson, Nov. 26-30, 1956.

Occlusion and What to Do About It, Dr. Bernard Jankelson, Dec. 3-6, 1956.

Advanced Orthodontics, Dr. Robert H. W. Strang, Jan. 20-Feb. 2, 1957.

Practice Administration, Dr. Jay H. Eshleman, Jan. 30-Feb. 1, 1957.

Periodontal Prosthesis, Dr. Morton Amsterdam and Dr. Walter Cohen, Feb. 11-16, 1957.

Orthodontics in Periodontal Therapy, Dr. Jack Alloy and Dr. Maxwell Fogelman, April 11-13, 1957.

For additional information and application, write to: Dr. Louis Herman, Postgraduate Division, Temple University School of Dentistry, 3223 North Broad St., Philadelphia 40, Pa.

The Ohio State University College of Dentistry announces a series of postgraduate courses to be presented during the 1956-1957 school year. The enrollment of each course is limited in order to permit intimate teaching.

Complete Denture Prosthodontics, Dr. Carl O. Boucher, Dec. 3 to 7 and Feb. 25 to March 1.

Endodontics, Dr. J. Henry Kaiser, Jan. 21 to 25.

Oral Diagnosis, Dr. Hamilton B. G. Robinson, Jan. 28 to Feb. 1.

Crown and Bridge, Dr. Frank C. Starr, Feb. 11 to 15.

Partial Denture Prosthodontics, Dr. Victor L. Steffel, Feb. 18 to 22.

General Anesthesia, Dr. Morgan L. Allison, March 4 to 8.

Anatomy of the Head and Neck, Dr. Linden F. Edwards, March 18 to 22.

Oral Surgery, Dr. Morgan L. Allison and Staff, April 8 to 12.

Pedodontics, Drs. Lyle S. Pettit and B. H. Williams, May 6 to 10.

Review of Clinical Dentistry, Dental Faculty, May 13 to 17.

For further information and application, write to Postgraduate Division, College of Dentistry, Ohio State University, Columbus 10, Ohio.

The Dental and Oral Surgery Service of the Mount Sinai Hospital in New York City announces that it is accepting applications for Internships and Residency for the calendar year beginning July, 1957. Application should be made to Dr. Max Fuchs, Assistant Director, The Mount Sinai Hospital, 11 East 100th Street, New York 29, New York.

The Ohio State University College of Dentistry announces that it is receiving applications of students for the Curriculum of Dental Laboratory Technology. This course of study of the laboratory phases of prosthodontics extends over two academic years and leads to a Certificate of Graduate Dental Laboratory Technologist. For further information write to the Chairman of Dental Laboratory Technology, Ohio State University College of Dentistry, Columbus 10, Ohio.

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Greater New York Academy of Prosthodontics Meeting, New York City, Dec. 1 and 2, 1956.

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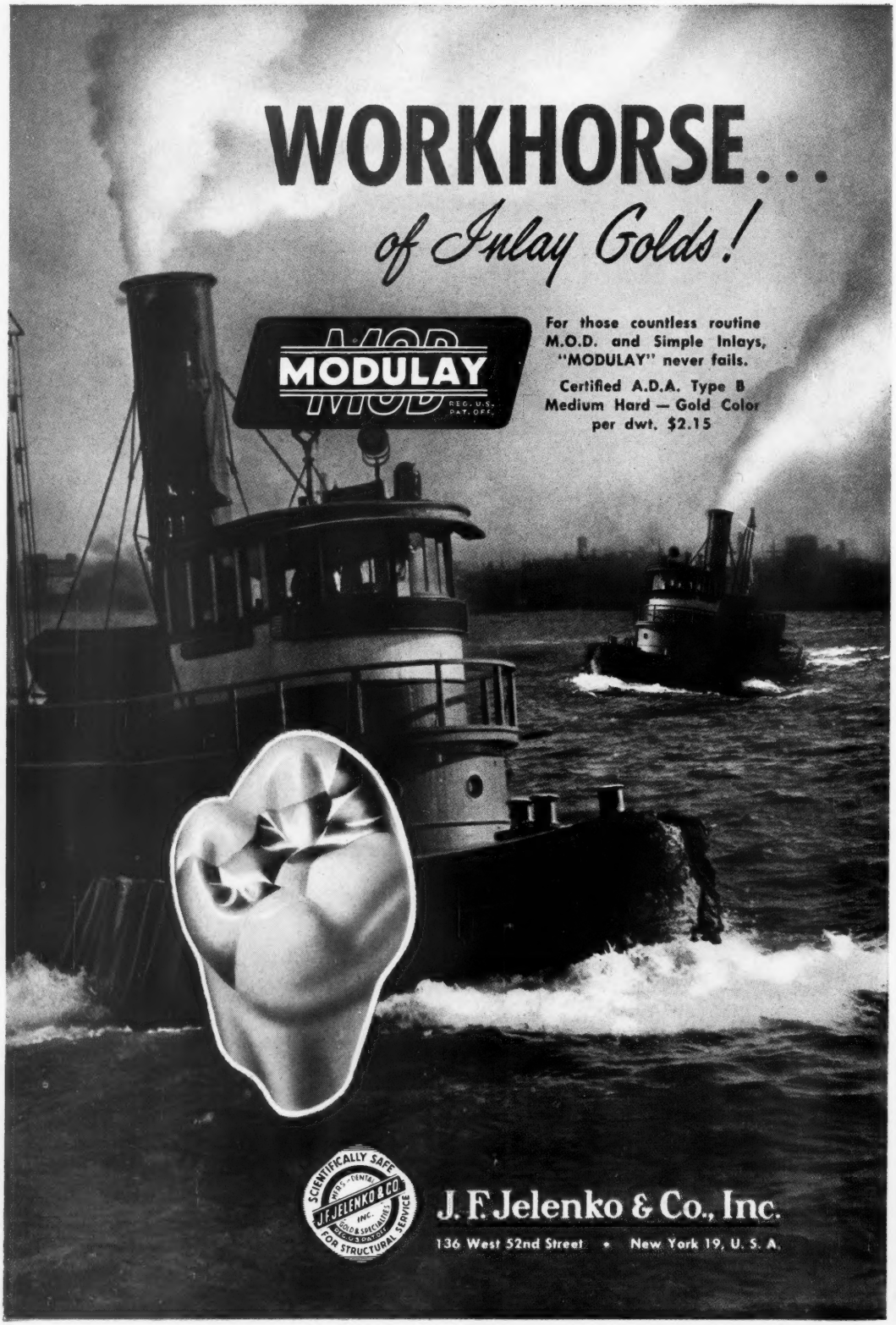
TABLE OF CONTENTS ON PAGE TWO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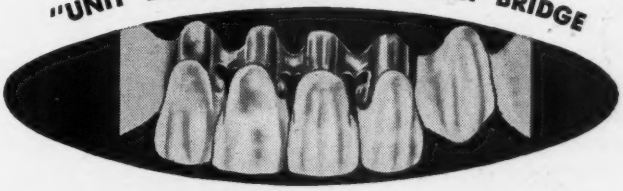

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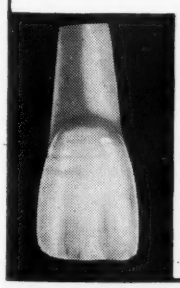

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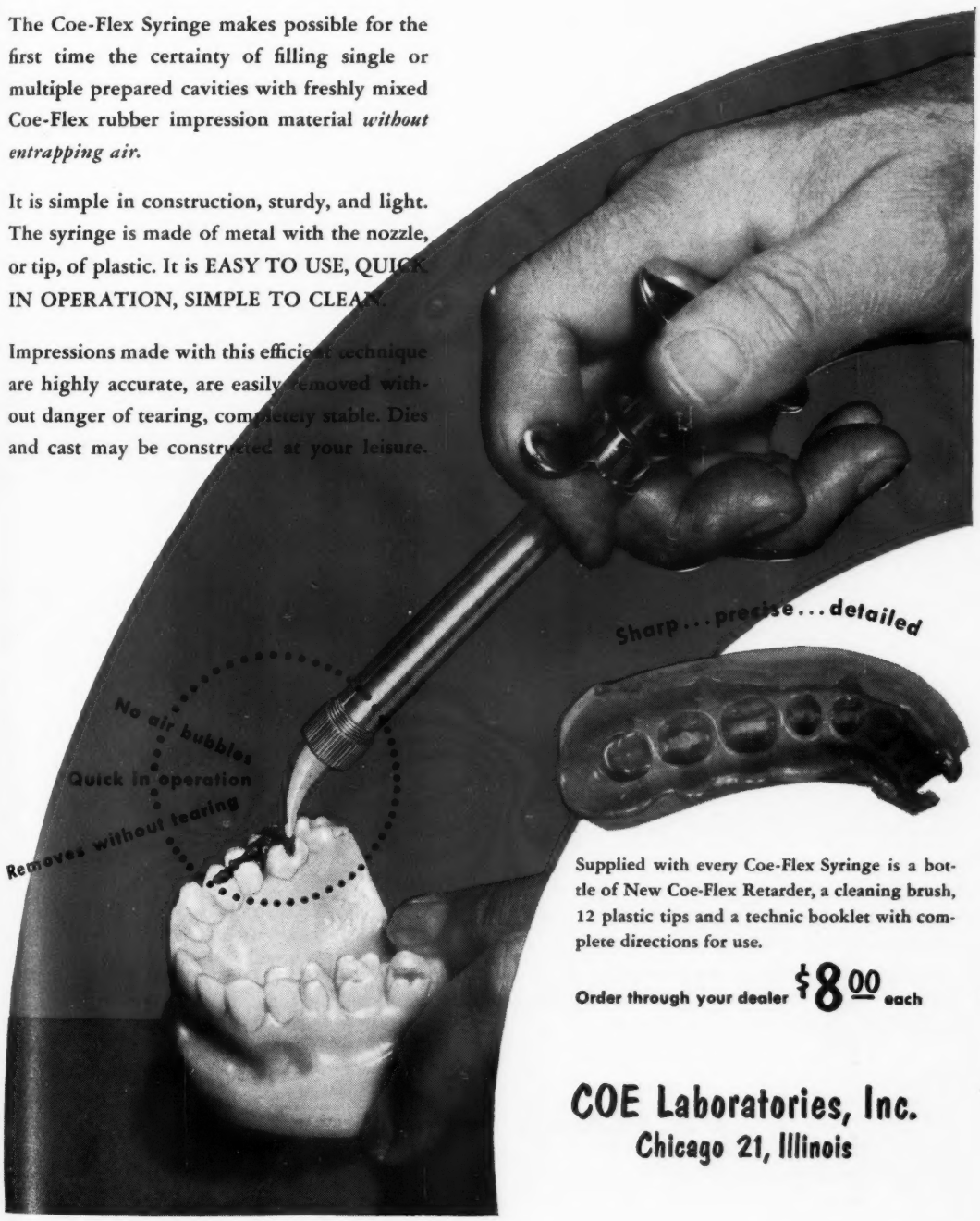

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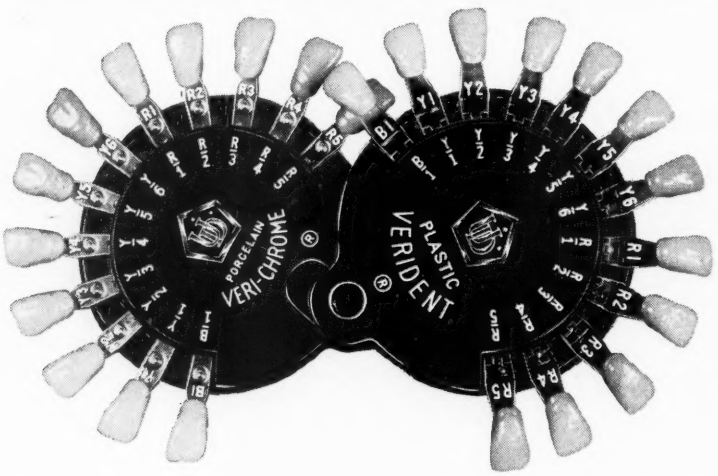

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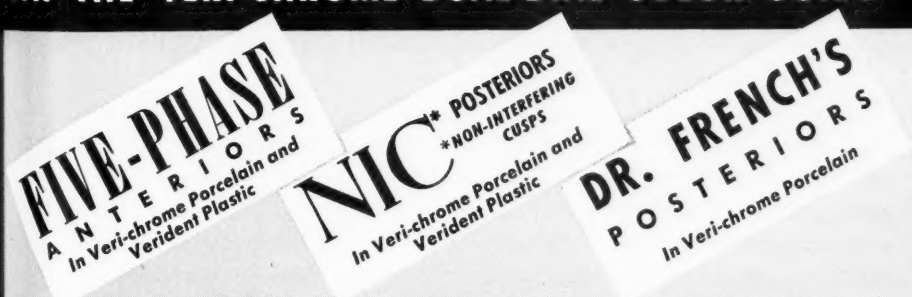

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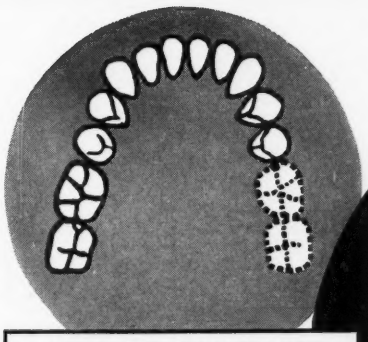

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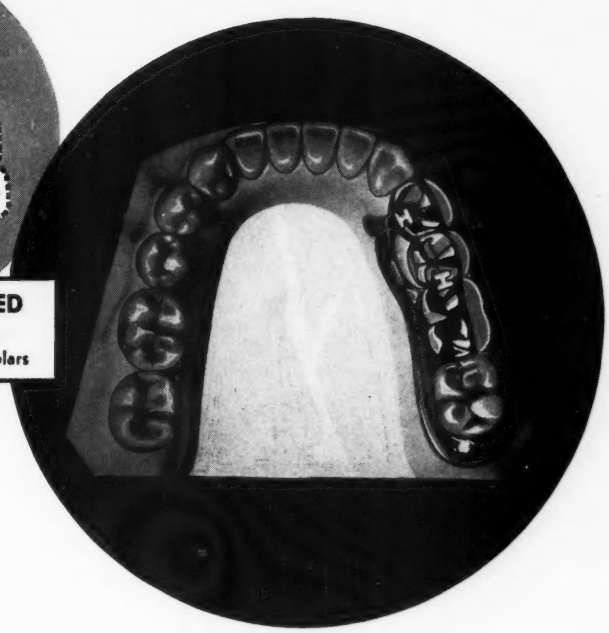

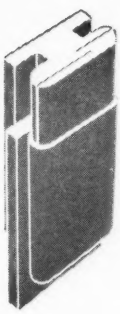

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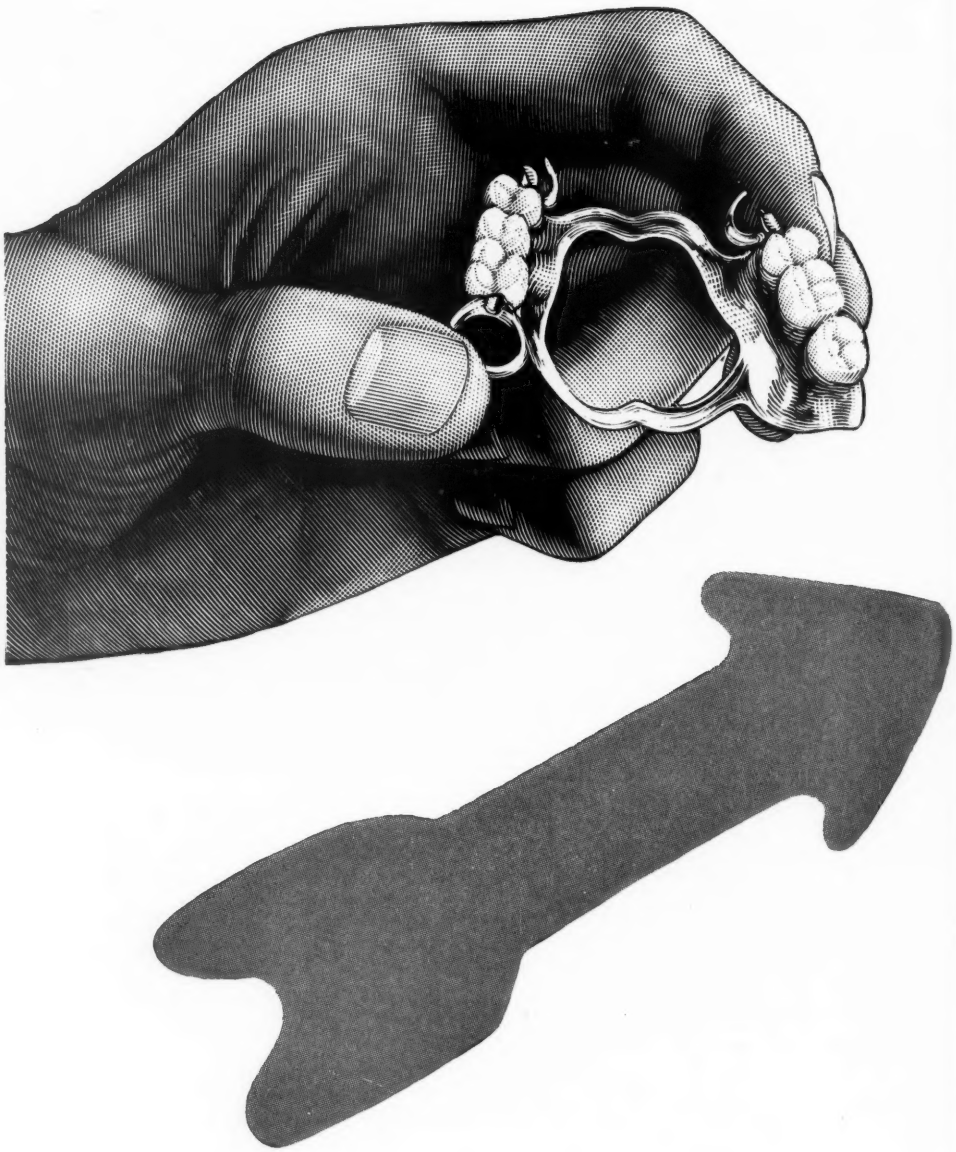

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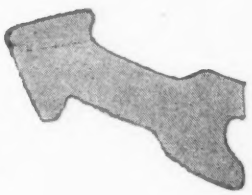

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and **KENNETH A. EASLICK, A.M., D.D.S.**, Ann Arbor, Michigan. Professor of Dentistry, School of Dentistry, University of Michigan.

386 pages.

This volume provides a summary of the fundamentals necessary for the efficient, ethical practice of dentistry, for professional improvement, and for participation in community life—a long uncharted area of professional concern. It is the outgrowth of the workshop held at the University of Michigan. Those who attended represented 31 states, the District of Columbia, and four provinces of Canada. Instructors from 26 dental schools were in attendance.

At this workshop dentists, dental hygienists, dental assistants, dental teachers, and others interested in the subject critically presented the data, information, and opinions available regarding the entire area of practice administration and determined the best patterns for the dentist to adopt in organizing and administering his practice and for filling his niche of professional responsibility in his community.

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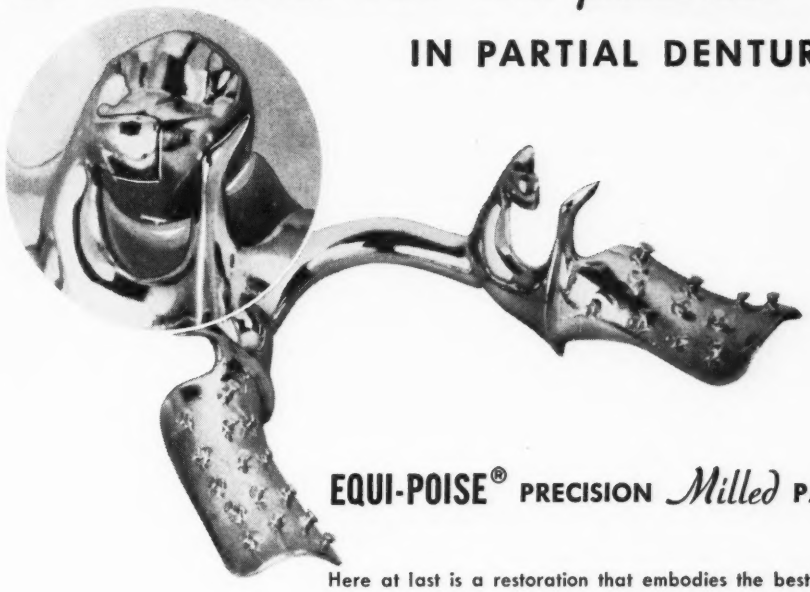

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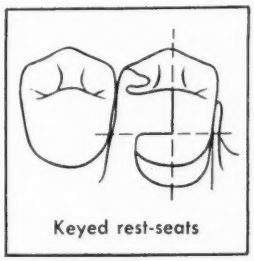

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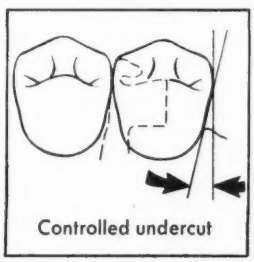

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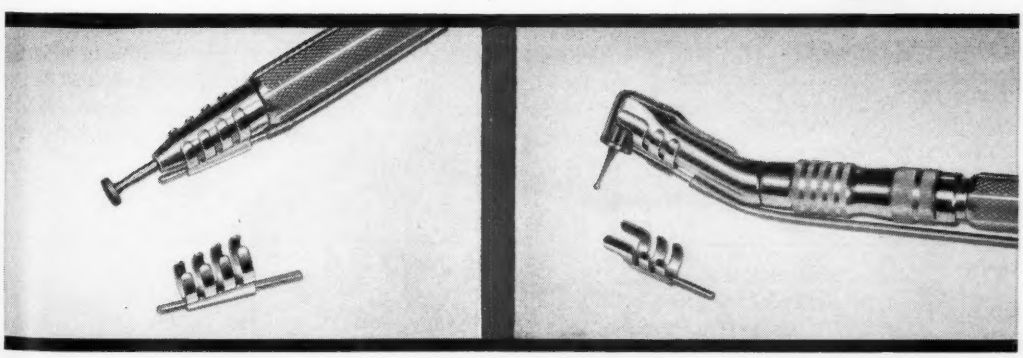

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- C. Principles of Ethics of the American Dental Association
- D. State Supervision and Control of the Profession

2—RESPECTIVE DUTIES OF DOCTOR AND PATIENT—HEREIN OF NEGLIGENCE
- A. Duties of Doctor to Patient
- B. Negligence and Contributory Negligence
- C. Duties of Patient

3—COMPENSATION FOR DENTAL SERVICES IN GENERAL
- A. General Principles of Contract Law
- B. Expressed Provisions by Patient and Dentist
- C. Express Promises Between Third Party and Dentist
- D. Implied Provisions as to Payment

4—COMPENSATION FOR DENTAL SERVICES AS TO PARTICULAR PERSONS

5—MALPRACTICE
- A. General Principles
- B. Error of Judgment
- C. Anesthetics
- D. X-Rays
- E. Technical Assault
- F. Miscellaneous Types of Malpractice

6—MALPRACTICE—SPECIAL RULES OF EVIDENCE
- A. Res Ipsa Loquitur
- B. Admissions Against Interest

7—MALPRACTICE DEFENSES
- A. Points Bearing on the Merits of the Case (Including a section on Receipt of Workman's Compensation)
- B. Release
- C. Statute of Limitations

8—LIABILITY FOR THE ACTS OF OTHERS
- A. Master and Servant—Principal and Agent
- B. Partners and Partnerships

9—INJURY TO THOSE OTHER THAN PATIENTS

10—THE DENTIST AS A WITNESS
- A. Dentist as Lay Witness
- B. Dentist as Expert Witness

by

CHARLES WENDELL CARNAHAN

Ph.B., J.D., LL.M., JUR. Sc.D.

Member of the State Bars of Illinois and Missouri; Professor of Law, Washington University, St. Louis, Missouri; and Lecturer on Dental Jurisprudence, School of Dentistry, Washington University.

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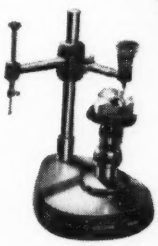

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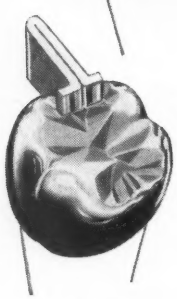

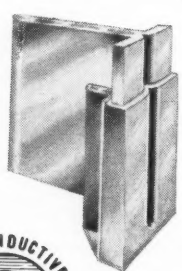

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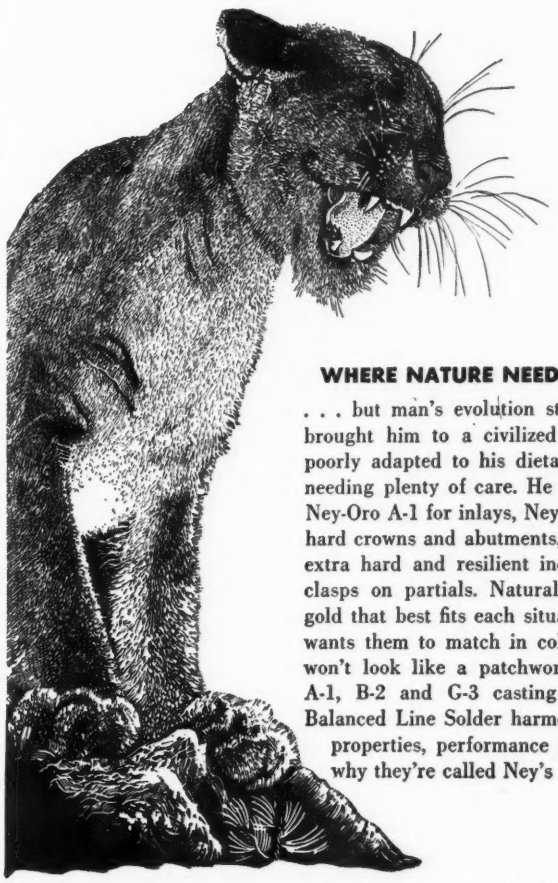

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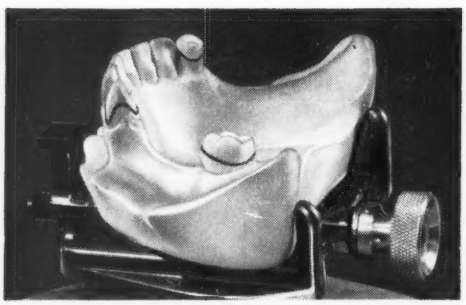

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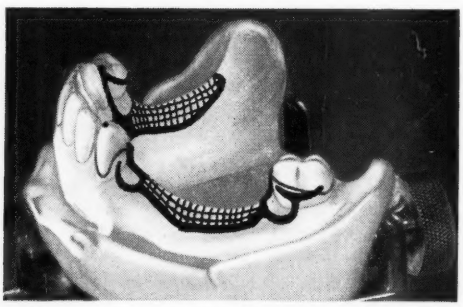

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by

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Professor of Denture Prosthesis, University of Oregon School of Dentistry; Formerly Professor of Prosthetic Dentistry, New York University College of Dentistry and **LOUIS G. TERKLA, D.M.D.**, Assistant Professor, Operative Dentistry, University of Oregon School of Dentistry.

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TABLE OF CONTENTS

PART I—
CONSTRUCTION OF PARTIAL DENTURES

1. Diagnosis, Prognosis, and Treatment Planning ..... 18 pages
2. The Study Materials Preliminary to Partial Denture Construction ..... 20 pages
3. Preparation of Abutments and Taking of Impressions ..... 11 pages
4. The Stone Cast and Bite Rims ..... 11 pages
5. Preliminary and Final Survey and Design .. 5 pages
6. Preparation and Duplication of the Master Cast ..... 17 pages
7. Clasps and Clasp Forms ..... 5 pages
8. Waxings the Bars and Webbing ..... 6 pages
9. Waxing the Clasps ..... 8 pages
10. Spruing and Investing of the Wax Pattern .. 7 pages
11. Elimination of Wax and the Casting of the Metal Base ..... 9 pages
12. Smoothing, Fitting, and Tempering the Casting ..... 16 pages
13. Construction of the Bite Rims, Face-Bow Transfer and Mounting of the Master Casts .. 26 pages
14. Setting of Teeth ..... 10 pages
15. Flasking, Processing, and Polishing ..... 13 pages
16. Insertion and Equilibration ..... 14 pages

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17. Classification of Partial Dentures ..... 15 pages
18. Surveying, Designing, and Planning ..... 8 pages
19. Saddle Outline and Design ..... 4 pages
20. Tooth Preparation for Clasping ..... 38 pages
21. Partial Denture Clasps ..... 7 pages
22. Partial Denture Impressions and Bite Rim Construction ..... 14 pages
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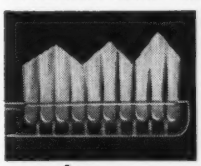

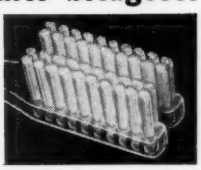

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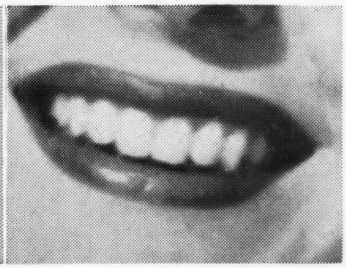

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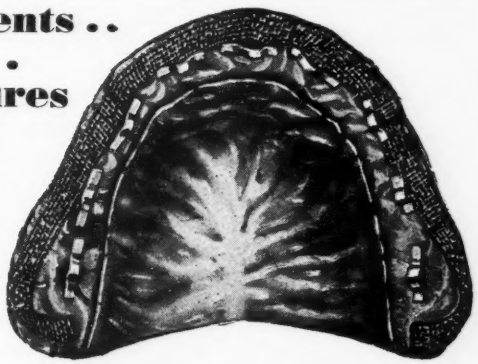

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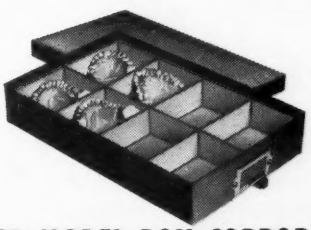

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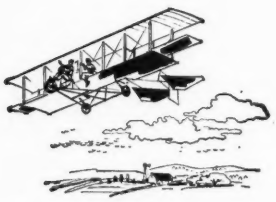

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The Management of ORAL DISEASE

A Treatise on the Recognition, Identification, and Treatment of Diseases of the Oral Regions

by

JOSEPH L. BERNIER, D.D.S., M.S., F.D.A., R.C.S. (Eng.) Colonel, Dental Corps, United States Army; Chief, Oral Pathology Branch, Armed Forces Institute of Pathology; Pathologist to the Registry of Oral Pathology of the American Dental Association; Professor of Oral Pathology, Georgetown University of Dentistry.

825 pages, 1001 illustrations, 5 color plates.

(Published 1955)

This book looks beyond disturbances of the tooth and its supporting apparatus to the diseases of the soft and hard structures of the oral regions, which have now been generally accepted as a responsibility of the dental profession. Specifically Doctor Bernier was prompted by these ideas in preparing this book:

- To make available a text which would embody the newer thoughts and definitions which define oral pathology in its modern sense.
- To emphasize the role of the dentist and oral pathologist in the identification and treatment of diseases of the oral regions.
- To present newer concepts relating to the role of stress, and the influence of general disease on oral disturbances.
- To clarify many unnecessarily complicated concepts regarding oral disease, by presenting explanations couched in simple language.
- To establish the relation between oral pathology and the clinical specialties of dentistry.
- To illustrate the role of oral pathology as it exists today in the teaching and practice of dentistry, as well as in general pathology.

Briefly the book covers diseases of the oral regions, including the tooth, the periodontium, the lips, cheeks, palate, floor of the mouth, tongue, maxilla and mandible, salivary glands and related areas.

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Bi-Po Company (Shorty & Dual Action Brushes)	25
Boos Dental Laboratories, Inc., Henry P. (Designed Cases)	22
Coe Laboratories, Inc. (Flex Syringe)	5
Dentists' Supply Company of New York, The (Bioform)	Fourth Cover
Hanau Engineering Company, Inc. (Therm-Ex Tri Jet)	16, 17
Hudson Products, Inc. (Polident)	1
Jelenko & Company, J. F. (Modulay)	Second Cover
Kerr Manufacturing Company (Permlastic)	13
Lamb Dental Laboratory, Chauncey H. (Zero-Minus balanced occlusion)	27
Moyer Company, Inc., The J. Bird (Bandit & Palatex-51)	4
Ney Company, The J. M. (Ney-Oro G-3 Gold)	21
Nudell, Uza (Swaged Dentures)	27
Nu-Dent Porcelain Studio, Inc. (Meta-por)	3
Permadent Products (Porcelain Crown & Bridge Work)	8
Stern-Goldsmith Corporation (Precision Attachments)	9
Superior Dental Laboratories (Partial Dentures)	15
Ticonium (Westgard-Stressguard Cases)	19
United States Savings Bonds	28
Universal Dental Company (Dual-Dial)	6, 7
University of Minnesota, The (Journal Wanted Advertisement)	25
Wernet Dental Manufacturing Company (Wernet's Powder)	Third Cover
White Dental Manufacturing Company, The S. S. (Oraline)	25
Williams Gold Refining Company, Inc. (Precision Attachment)	20

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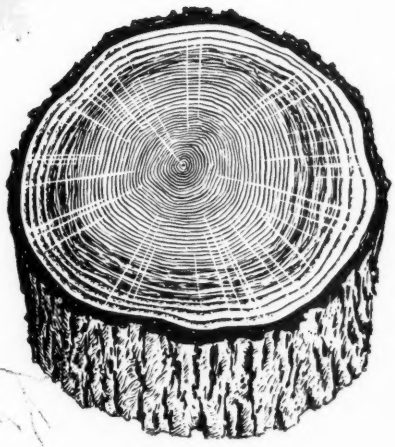

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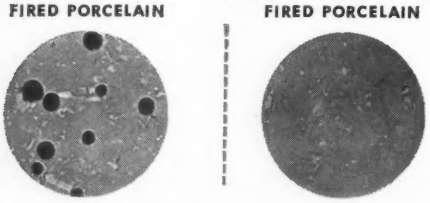

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GLOSSARY
of
PROSTHODONTIC TERMS

GLOSSARY

of

PROSTHODONTIC TERMS

by

THE ACADEMY OF DENTURE PROSTHETICS

Edited by

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PREFACE

THIS GLOSSARY IS A COLLECTION of words and terms and their special connotations in the art and science of prosthodontics. It is in the nature of a progress report in a tremendous effort to standardize the nomenclature used in this field. The advantages to the dental profession of a successful effort in this direction are manifold. The most important of these is that the use of a uniform terminology would permit authors to discuss their concepts and techniques and be sure that these would be understood by those who would read the articles, regardless of the geographic location or the specialty of the reader.

The need for a glossary of terms used in prosthodontics has been recognized for many years. In 1923, Ottofy* stated, "It is to be hoped that members of the profession and specialists through their organizations will reach an agreement as to the terms to be given preference or to be used exclusively." He called particular notice to the confused state of the prosthodontic terminology of that time, and it is even worse now because of the progress in the art and science of prosthodontics. Many new terms and words intended to describe or explain modern philosophies or procedures have been added to the literature. Many different interpretations and meanings have been ascribed by authors, clinicians, and teachers to the same terms and words. Many "old" terms have been given "new" definitions by contemporary authors. Many "old" terms have been redefined in the light of the increased knowledge of the problems of prosthodontics.

Through the years many sincere attempts have been made by individuals, specialty groups, and the Bureau of Library and Indexing of the American Dental Association to develop a standard and acceptable nomenclature in dentistry. The major obstacle has been the difficulty in obtaining universal acceptance of proposed interpretations.

The Academy of Denture Prosthetics has studied the problem throughout its existence and, until recently, has reached unanimous agreement on very few terms. This was in spite of sincere and valiant efforts on the part of the nomenclature committees, and it was due to the wide differences of opinion and background among those who considered the committees' recommendations. This lack of progress was most discouraging, but three years ago it was agreed by the Fellowship of the Academy that this Glossary would be prepared, and that the *majority* opinion would be adopted. This decision made possible real progress toward the ultimate goal—a universal terminology for prosthodontics.

The "workshop" technique was used in the course of two meetings of the Academy for the study of nearly 1,000 words or terms. The results of these "workshop" sessions were restudied by the Nomenclature Committee of the Academy. At least sixteen outstanding prosthodontists have given serious study to each term included in this Glossary. The definitions represent a composite of their understanding of the terms. The Fellows of the Academy of Denture Prosthetics have combined their efforts to serve as lexicographers.

*Ottofy, Louis: Standard Dental Dictionary, Chicago, 1923, Laird and Lee, Inc., p. IX.

The chief role of a lexicographer is to record the current usage of words. The chief function of words in science is to convey meaning.

The lexicographer has a duty to *lead* as well as to follow. Where clearness demands it, he should place such restrictions as are necessary to avoid ambiguity. That is, he must narrow down some definitions so they will not carry too much generality. Where voids exist, he should fill them in. Where more than one term is used to express the same idea or concept, he should indicate the preference on the basis of logic and other considerations.

Many instances could be cited in the Glossary where the Academy and its Nomenclature Committee have performed these various "duties" of the lexicographer. Certain terms were determined to be objectionable for some reason and are marked (Obj.). Some new terms have been added which seem to express the desired ideas or meanings more accurately than the corresponding terms in current usage. Where more than one term which carries the same connotation was found, the *preferred* term is listed first. Likewise, when more than one definition was assigned to the same term, the preferred definition is listed first. These decisions were made on the basis of *majority* opinion. It is hoped that eventually obsolete or objectionable terms and terms which tend to mislead and confuse will be eliminated entirely.

This, the first edition of the Glossary, is offered to the dental profession for its consideration. Since it is recognized that there are some terms which have not been included, and that some other terms and definitions which may be objectionable to some authorities have been included, revisions will be necessary from time to time. Constructive suggestions are invited, and these will be given thorough consideration in future editions. In its present form, this Glossary can serve as a good temporary standard.

It is impossible to give due credit here to all who have worked to make this Glossary possible. The Fellows of the Academy of Denture Prosthetics have supplied the fundamental information and have made the necessary decisions. The Editorial Council of the JOURNAL OF PROSTHETIC DENTISTRY, and The C. V. Mosby Company, its publisher, have provided encouragement and technical assistance in its development. Special acknowledgment is due to Dr. George B. Denton of the Bureau of Library and Indexing of the American Dental Association, for his advice and counsel, and to Mrs. Marice K. Musgrove and Miss Barbara Eichhorn for the tremendous amount of secretarial work which was necessary. Acknowledgment is made, also, to certain dictionaries and textbooks from which the definitions for some of the terms have been taken. These are: Dorland, W. A. Newman, The American Illustrated Medical Dictionary, ed. 22, Philadelphia, 1951, W. B. Saunders Co. (Dor.); Dunning, William B., and Davenport, S. Ellsworth, Jr., A Dictionary of Dental Science and Art, Philadelphia, 1936, P. Blakiston's Son & Co., Inc. (D. & D.); Swenson, Merrill G., and Terkla, Louis G., Partial Dentures, St. Louis, 1955, The C. V. Mosby Co. (S.); *Blakiston's* New Gould Medical Dictionary, ed. 1, Philadelphia, 1949, The Blakiston Co. (Gould). To all of these, the Nomenclature Committee expresses its gratitude.

THE NOMENCLATURE COMMITTEE
ACADEMY OF DENTURE PROSTHETICS

GLOSSARY
of
PROSTHODONTIC TERMS

A

abrasion The grinding or wearing away of tooth substance by mastication, incorrect tooth-brushing methods, and similar causes.

abrasive A substance used for abrading, grinding, or polishing.

absorption The taking up of fluids or other substances by the skin, mucous surfaces, absorbent vessels, or dental materials.

abutment A tooth used for the support or anchorage of a fixed or removable partial denture appliance.

intermediate a. A natural tooth, without other natural teeth in proximal contact, which is used as an abutment.

accelerator 1. A catalytic agent used to hasten a chemical reaction (e.g., NaCl or K_2SO_4 added to plaster of Paris and water to hasten setting). 2. A substance used to speed chemical reaction.

acentric relation (Obj.) (See *eccentric relation*)

acquired centric relation (Obj.) (See *eccentric relation*) (See also *centric relation*)

acrylic Improperly used as a noun. Should be used as in *acrylic resin, acrylic resin denture, acrylic resin tooth,* etc.

adhesion 1. The physical attraction of unlike molecules for one another. 2. The molecular attraction existing between the surfaces of bodies in contact.

adjustment A modification made upon a denture, or upon the teeth on a denture after it has been completed and inserted in the mouth.

occlusal a. Modification of the occluding surfaces of teeth for providing harmonious relations between these surfaces.

air-chamber (Obj.), **relief chamber** (See *relief*)

alginate (See *hydrocolloid*) 1. An irreversible hydrocolloid consisting of salts of alginic acid, 2. In dentistry, it is used primarily for making impressions.

alveolar bone The specialized bone structure which supports the teeth.

alveolar ridge (See *ridge, residual ridge*)

alveolus The socket in the bone in which the teeth are attached by means of the periodontal membrane.

anatomic crown That portion of a tooth extending toward the occlusal surface or incisal edge from the cemento-enamel junction. (See *clinical crown*)

anneal The softening of a metal by controlled heating and cooling. The process makes a metal more easily adapted, bent, or swaged and less brittle.

anti-Monson curve (Obj.) (See *revere curve*)

appliance (See *restoration*)

apposition The condition of being placed or fitted together; juxtaposition; coadaptation.

arch form The shape of the dental arch.

articulate (Obj.) (See *tooth arrangement*)

articulation (See *tooth arrangement*) 1. (anatomic) A bony joint which may or may not be movable. 2. (dental) The relating of casts of the upper and lower jaws, by means of an artificial joint (or articulator) adjusted to correspond in various respects to the joints of the patient (subject), enabling the dentist to duplicate or simulate some of the movements of the patient's mandible. 3. The contact relation of the incisal and occlusal surfaces of the opposing teeth during lateral and protrusive movements of the mandible. (Obj.) 4. The arrangement of artificial teeth. (Obj.) 5. (speech) Enunciation of distinct connected speech.

temporomandibular a., temporomandibular joint 1. The joint formed by the mandibular condyle and the glenoid fossa. 2. The articulation of the condyloid process of the mandible and the interarticular disc with the mandibular fossa of the temporal bone.

articulator A mechanical device which represents the temporomandibular joints and jaw members, to which maxillary and mandibular casts may be attached.

adjustable a. An articulator capable of adjustment to more than one eccentric position.

artificial denture (Obj.), **complete denture** (See *denture*)

artificial stone A specially calcined gypsum derivative similar to plaster of Paris with a physical difference in that the grains are nonporous, thereby resulting in a product which is stronger than plaster of Paris.

attachment A mechanical device for the fixation and stabilization of a dental prosthesis.

precision a., internal a., frictional a., slotted a., key and keyway a., parallel a. 1. One that depends upon resistance between parallel walls of male and female parts. 2. A frictional retainer used in fixed and removable partial denture construction that consists of closely fitting male and female parts. 3. An attachment which depends upon the friction between its parts for the retention of a prosthetic appliance. 4. An attachment consisting of a male and female part, the former of which may be expanded to afford frictional retention.

autopolymer A plastic (resin) which polymerizes without external heat due to the addition of an activator and a catalyst.

autopolymer resin, activated resin, cold cure resin, self-curing resin (See also *resin*) 1. A resin which does not require external heat to start its polymerization. 2. Any resin which can be polymerized by an activator and a catalyst.

autopolymerization Polymerization without the use of external heat, due to the addition of an activator and a catalyst.

axis A straight line around which a body may rotate.

condylar a. A line through the two mandibular condyles around which the mandible may rotate during any part of the opening movement.

hinge a. An imaginary line between the temporomandibular joints around which the mandible may rotate without translatory movement.

opening a. An imaginary line around which the condyles may rotate during opening and closing movements of the mandible.

B

backing A metal support which fits the inner surface of a facing, and serves to attach the facing to the prosthesis.

balance This term has no value in prosthodontics unless it is combined with another word or phrase, e.g., occlusal balance. (See *occlusion*)

balanced articulation (Obj.) (See *balanced occlusion*) An occlusion in which the occluding surfaces are in harmony as the mandibular teeth glide over the maxillary teeth.

balanced bite (Obj.) (See *balanced occlusion*)

balanced occlusion (See *occlusion*) The simultaneous contacting of the upper and lower teeth on the right and left and in the anterior and posterior occlusal areas. This occlusion is developed to prevent a tipping or rotating of the denture bases in relation to the supporting structures. It is thought of primarily in the mouth, but it is arranged and may be observed on articulators.

mechanically b. o. The harmonious relation of the occluding surfaces of teeth in centric or eccentric positions within their functional range without reference to physiologic considerations.

physiologically b. o. The harmonious relation of the occluding surfaces of teeth with one another and with the temporomandibular articulations and with the neuromuscular system. The contact relations of opposing teeth which establish a state of equilibrium of the opposing dental arches when they are placed in various relations to each other.

balancing contacts 1. The contacts between upper and lower dentures on the balancing side for the purpose of stabilizing the dentures. 2. The contacts between upper and lower den-

tures at the opposite side from the working side (anteroposteriorly or laterally) for the purpose of stabilizing the dentures.

balancing occlusal surfaces The occluding surfaces of dentures on the balancing side (anteroposteriorly or laterally) which are developed for the purpose of stabilizing dentures.

balancing side The side opposite the working side. (See *working side*)

bar A segment or unit of a partial denture.

clasp b. A retaining or stabilizing arm of a bar clasp. (See *clasp*)

connector b. A tang, a minor connector for a partial denture.

labial b. A major connector located labial to the dental arch joining two or more bilateral parts of a mandibular removable partial denture.

lingual b. A major connector located lingual to the dental arch joining two or more bilateral parts of a mandibular removable partial denture.

palatal b. A major connector which crosses the palate and unites two or more parts of a maxillary removable partial denture.

basal bone The osseous tissue of the mandible and maxillae excepting the alveolar processes of these bones.

basal seat The entire tissue area covered by the denture base.

base material Any substance from which a denture base may be made, such as shellac, acrylic resin, vulcanite, polystyrene, metal, etc.

baseplate, record base A temporary form to represent the base of a denture which is used for making maxillomandibular (jaw) relation records and for the arrangement of teeth.

stabilized b. A baseplate lined with a plastic material to improve its fit and stability.

Bennett angle The angle formed by the sagittal plane and the path of the advancing condyle during lateral mandibular movement as viewed in the horizontal plane.

Bennett movement The bodily lateral movement or lateral shift of the mandible resulting from the movements of the condyles along the lateral inclines of the mandibular fossae in lateral jaw movement.

biscuit bite (Obj.) (See *maxillomandibular record*)

bite (Obj.) (See *interocclusal record, checkbite, maxillomandibular registration, denture space, interarch distance*) The term "bite" should be reserved for the act of incision, a morsel of food, and in connection with discussions of the amount of pressure developed in closing the jaws, etc.

bite analysis (Obj.) (See *occlusal analysis*)

bite block (Obj.) (See *occlusion rim*)

bite closing (Obj.) (See *vertical dimension decrease*)

bite opening (Obj.) (See *vertical dimension increase*)

bite raising (Obj.) (See *vertical dimension increase*)

bite rim (Obj.) (See *occlusion rim*)

biting pressure (Obj.) (See *occlusal pressure*)

biting strength (Obj.) (See *masticatory force*)

Bonwill triangle An equilateral triangle bounded by lines from the contact points of the lower central incisors, or the medial line of the residual ridge of the mandible, to the condyle on either side and from one condyle to the other.

border The circumferential margin or edge.

b. molding The shaping of an impression material by the manipulation or action of the tissues adjacent to the borders of an impression.

b. seal The contact of the denture border with the underlying or adjacent tissues to prevent the passage of air or other substances.

border tissue movements The action of the muscles and other tissues adjacent to the borders of a denture.

boxing (an impression) The building up of vertical walls, usually in wax, around the impression to produce the desired size and form of the base of the cast, and to preserve certain landmarks of the impression.

boxing wax Wax used for boxing impressions.

bracing Resistance to horizontal components of masticatory force.

bridge (Obj.), **fixed partial denture** (See *partial denture*)

bruxism A clenching of the teeth associated with forceful lateral or protrusive jaw movements which results in rubbing, gritting, or grinding together of teeth, usually during sleep. (Grinding the teeth during sleep is a pathologic condition.)

bruxomania Grinding of the teeth as a neurotic symptom.

buccal 1. Pertaining to, or adjacent to, the cheek. 2. The surface of the posterior teeth adjacent to the cheek's buccal vestibule or buccal cavity.

buccal surface (of dentures) The side of a denture adjacent to the cheek.

buccolingual relationship The position of a space or tooth in relation to the tongue and the cheek.

butt 1. To place directly against the tissues covering the alveolar ridge. 2. To bring any two square-ended surfaces in contact, as in a butt joint.

C

Camper's line The line running from the inferior border of the ala of the nose to the superior border of the tragus of the ear.

capillary attraction That quality or state, which owing to surface tension, causes elevation or depression of the surface of a liquid that is in contact with a solid.

case Obj.) 1. Not a good term to use to refer to a stage of prosthetic work. Patient, flask, denture, casting, etc., are better terms as they may apply. 2. A particular instance of disease or injury, as a case of typhoid fever. A case is not synonymous with a patient, for the latter is the human being affected with the disease.

cast 1. An object formed or poured in a matrix or impression, as of metal, plaster, etc. 2. A positive likeness of some desired form. 3. A positive reproduction of the form of the tissues of the upper or lower jaw, which is made in an impression, and over which denture bases or other dental restorations may be fabricated.

- **master c.** A replica of the prepared tooth surfaces, residual ridge areas, and/or other parts of the dental arch as reproduced from an impression.
- **refractory c.** 1. A cast made of a material which will tolerate high temperatures without disintegrating. 2. A cast made of an investment material which will not disintegrate at temperatures used in casting and/or soldering.
- **study c.** 1. A reproduction of dental structures for the purpose of study and treatment planning. 2. A cast made for the purpose of occlusal analysis or other study for treatment planning.

casting 1. A metallic object formed in a mold. 2. The act of forming a casting in a mold.

- **vacuum c.** The casting of a metal in the presence of a vacuum.

casting flask (See *flask*)

casting ring (See *flask*)

casting wax A chemical composition containing various waxes with controlled properties of thermal expansion and contraction, used in making wax patterns to determine the shape of metal castings.

cement 1. A material which hardens with adhesive effect. 2. A type of filling material.

cementation 1. The process of attaching parts by means of a cement. 2. Attaching artificial teeth to a restoration by means of a cement. 3. Attaching a restoration to natural teeth by means of a cement.

central bearing Application of forces between the maxillae and mandible at a single point which is located as near as possible to the center of the supporting areas of the upper and lower jaws. It is used for the purpose of distributing closing forces evenly throughout the areas of the supporting structures during the registration and recording of maxillomandibular (jaw) relations and during the correction of occlusal errors.

central-bearing device A device which provides a central point of bearing, or support between upper and lower occlusion rims. It consists of a contacting point which is attached to one

occlusion rim and a plate which provides the surface on which the bearing point rests or moves.

c.-b. tracing device A central-bearing device which is used for making a tracing and/or for support between occlusion rims.

central-bearing point The contact point of a central-bearing device.

centric checkbite (Obj.) (See *maxillomandibular record, interocclusal record, checkbite*)

centric position The position of the mandible when the jaws are in centric relation. (See *centric relation*)

centric relation The most retruded relation of the mandible to the maxillae when the condyles are in the most posterior unstrained position in the glenoid fossae from which lateral movement can be made, at any given degree of jaw separation.

checkbite (Obj.) (See *maxillomandibular record, interocclusal record*) A record of the relation of the mandible to the maxillae made in a plastic material which hardens, such as plaster of Paris, wax, zinc oxide and eugenol paste.

centric c. A record of the centric jaw position (relation).

eccentric c. A record of a jaw relation other than centric position.

lateral c. A record of a lateral eccentric jaw position.

protrusive c. A record of a protruded eccentric jaw position.

chewing cycle 1. A complete course of movement of the mandible during a single masticatory stroke. 2. The path of a point on the mandible or on a mandibular tooth as movement occurs during the mastication of food.

chewing force The degree of force applied by the muscles of mastication during the mastication of food.

clasp 1. A part of a removable partial denture which acts as a retainer and/or stabilizer for the denture by partially surrounding or contacting an abutment tooth. 2. A retainer of a removable partial denture, usually consisting of two arms joined by a body which connects with an occlusal rest. At least one arm of a clasp is usually in the infrabulge (gingival convergence) area of the tooth enclosed.

bar c. 1. A clasp in which the arms are direct bar extensions from major connectors or base (saddle) of the appliance; it traverses soft tissue through much of its extent and contacts the tooth at its terminal portion or portions, at least one of which is usually in the infrabulge (gingival convergence) area. 2. A clasp which consists of two or more separate and distinct arms located opposite to each other on the tooth. The bar arms arise from the framework or a connector and largely traverse the soft tissue. One arm (bar) usually terminates in the infrabulge (gingival convergence) area of the tooth and is retentive, and the other usually on the suprabulge (occlusal convergence) area, and acts as a reciprocal arm. (The term, bar type clasp, should be changed to bar type retention.)

circumferential c. A clasp that encircles more than 180 degrees of a tooth, including opposite angles, and which usually contacts the tooth throughout the extent of the clasp, at least one terminal being in the infrabulge (gingival convergence) area.

clasp bar (See *bar*)

clasp guide line (See *survey line*)

clinical crown That portion of the tooth that is exposed in the mouth beyond the soft tissues and may consist of part of the root as well as the anatomic crown. (See *anatomic crown*)

close bite (Obj.), **small interarch distance** (See *interarch distance*)

closed bite (Obj.) (See *reduced interarch distance*)

comminution of food The reduction of food into small parts.

compensating curve The anteroposterior and lateral curvature in the alignment of the occlusal surfaces and incisal edges of artificial teeth which is used to develop balanced occlusion.

component of force 1. One of the factors from which a resultant force may be compounded or into which it may be resolved. 2. One of the vectors into which a force may be resolved.

components of mastication (See *mastication*)

components of occlusion The various factors which are involved in occlusion, such as the temporomandibular joint, the associated neuromusculature, the teeth, and the denture-supporting structures.

compression molding 1. The act of pressing or squeezing together to form a shape in a mold. 2. The adaptation of a plastic material to the negative form of a split mold by pressure. (See *injection molding*)

compression of tissue (Obj.) (See *displaceability of tissue*)

condylar guidance, condylar guide The mechanical device on an articulator which is intended to produce similar guidances in articulator movement as are produced by the paths of the condyles in the temporomandibular joints.

condylar guidance inclination, condylar guide inclination The angle of inclination of the condyle guidance to an accepted horizontal plane.

condyle The rounded articular surface at the articular end of a bone.

mandibular c. The articular process of the mandible.

condyle axis (Obj.), **condylar axis** (See *axis*)

condyle chord (Obj.), **condylar axis** (See *axis*)

condyle head (Obj.) (See *condyle*)

condyle path 1. The path traveled by the mandibular condyle in the temporomandibular joint during the various mandibular movements. 2. The path traveled by the condyle.

connector A part of a partial denture which unites the other component parts of a partial denture. It unites the retainer with the pontic or denture base. It may be rigid, as in a soldered joint, or nonrigid, as in the tapered key or stress-breaker type.

major c. A plate or bar (lingual bar, palatal bar) used for the purpose of uniting the stabilizing partial denture bases.

minor c. The connecting link (tang) between the major connector or base of a partial denture and other units. (Clasps, indirect retainers, occlusal rests, etc., of the restoration.)

connector bar (See *bar*)

continuous bar retainer A metal bar, usually resting on lingual surfaces of teeth, to aid in their stabilization and to act as indirect retainers.

continuous clasp (Obj.) (See *continuous bar retainer*)

contour (*n*) The external shape or form of an object. (*v*) To create the external shape or form of an object, as of a denture.

coping A thin metal covering or cap.

counterdie The reverse image of a die, usually made of a softer and lower fusing metal than the die. (See *die*)

crazing (of plastic teeth) Minute cracks appearing on the surface of plastic teeth.

crown (artificial) A fixed restoration of the major part or of the entire coronal part of a natural tooth.

cure The hardening process of a denture base, as by polymerization or vulcanization.

curve of occlusion 1. A curved surface which makes simultaneous contact with the major portion of the incisal and occlusal prominences of the existing teeth. 2. The curve on which the occlusal surfaces lie.

curve of Spee 1. Anatomic curvature of the occlusal alignment of teeth beginning at the tip of the lower cuspid and following the buccal cusps of the natural bicuspids and molars, continuing to the anterior border of the ramus. 2. The anatomic curvature of the occlusal alignment of teeth described by von Spee.

cusp angle 1. The angle made by the sides of a cusp with the plane which passes through the summit of the cusp and which is perpendicular to a line bisecting the cusp, measured mesiodistally or buccolingually. 2. The angle made by the sides of a cusp with a perpendicular line bisecting the cusp, measured mesiodistally or buccolingually. 3. One-half of the included angle between the buccal and lingual or mesial and distal cusp inclines.

cusp height 1. The shortest distance between the summit of a cusp and its base plane. 2. The shortest distance between the deepest part of the central fossa of a posterior tooth and a line connecting the points of the cusps of the tooth.

cuspal interference The contact of any cusp with an opposing tooth which prevents the contact of other cusps during any of the various excursions of the mandible.

D

deflective occlusal contact (See *cuspal interference and interceptive occlusal contact*) Contact that is capable of guiding the mandible from its original path of action into a different path of motion, or capable of disturbing the relation between a denture base and its supporting tissues.

dental dysfunction 1. Abnormal functioning of a dental mechanism. 2. Partial disturbance or impairment of the functioning of a dental organ.

dental engineering 1. The application of mechanical and mathematical principles to the solution of dental problems. 2. The application of engineering principles to dentistry.

dental geriatrics 1. Treatment of dental problems peculiar to old age. 2. Dentistry for the aged.

dental senescence That condition of the teeth and associated structures in which there is deterioration due to aging or premature aging processes.

dentition The natural teeth in position in the dental arches.

dentulous A condition in which natural teeth are present in the mouth.

denture An artificial substitute for missing natural teeth and adjacent tissues.

d. base 1. That part of a complete or partial denture which rests upon a basal seat area and to which teeth are attached. 2. That part of a denture which rests on the oral mucosa and to which teeth are attached.

d. border, d. edge 1. The limit or boundary or circumferential margin of a denture base. 2. The margin of the denture base at the junction of the polished surface with the impression (tissue) surface. 3. The extreme verge of the denture base at the buccolabial, lingual, and posterior limits.

complete d. 1. An artificial replacement of the maxillary and/or mandibular dentition and associated structures. 2. An appliance restoring the complete loss of the natural teeth and associated structures.

continuous gum d. An artificial denture consisting of porcelain teeth and tinted porcelain denture base material, fused to a platinum base.

duplicate d. 1. A second denture identical with the first. 2. A denture made to approach as nearly as possible every detail of a given denture.

immediate insertion d., immediate d. A dental prosthesis constructed for insertion immediately following removal of natural teeth.

d. impression surface That portion of the surface of a denture which has its contour determined by the impression. It includes the borders of the denture and extends to the polished surface.

d. occlusal surface That portion of the surface of a denture which makes contact or near contact with the corresponding surface of the opposing denture or dentition.

partial d. An artificial replacement of the missing parts of an incomplete complement of natural teeth and their adjacent tissues.

d. polished surface That portion of the surface of a denture which extends from the border of the denture to the occlusal surface of a denture including the palatal surface. It is the part of the denture base which is usually polished and includes the buccal and lingual surfaces of the teeth.

denture-bearing area (Obj.) (See *denture foundation*)

denture characterization Modification of the form and color of the denture base and teeth to produce a more lifelike appearance.

denture curing The process in which the denture base materials are hardened to the form of a denture in a denture mold.

denture design A planned visualization of the form and extent of a dental prosthesis, arrived at after a study of all factors involved.

denture edge, denture border (See *denture*)

denture foundation That portion of the basal seat that supports the denture base under occlusal load. (See *basal seat*)

denture packing (See *packing*)

denture prognosis (See *prognosis*)

denture retention The means by which dentures are held in position in the mouth.

denture service Those procedures which are involved in the diagnosis, construction, and maintenance of artificial substitutes for missing natural teeth.

denture space The vertical distance between the residual ridges which is available for dentures. (See also *vertical dimension*)

denture stability The resistance to the movement of a denture on its basal seat.

denture supporting area (Obj.) (See *denture foundation*)

denture supporting structures The tissues, either teeth and/or residual ridges, which serve as the foundation for removable partial or complete dentures.

diagnosis A scientific evaluation of existing conditions.

diastema A space between two teeth in the same dental arch.

die The positive reproduction of the form of a prepared tooth in any suitable hard substance, usually in metal or specially prepared artificial stone. (See *counterdie*)

dimensional stability The property of a material to retain its size and form.

direct bone impression An impression of denuded bone, used in the construction of denture implants.

displaceability of tissue The property of tissue which permits it to be moved from an initial position.

distal 1. Away from the median sagittal plane of the face following the curvature of the dental arch. 2. In a dorsal direction from any given point of reference.

distal end The posterior extremity of any dental appliance.

dynamic relations Relations of two objects involving the element of relative movement of one object to another as the relationship of the mandible to the maxillae.

E

eccentric checkbite (Obj.) (See *checkbite*)

eccentric position Any position of the mandible other than centric position.

eccentric relation (See *eccentric position*) Any relation of the mandible to the maxillae other than centric relation. (See *centric relation*)

edentulate (Obj.) (See *edentulous*)

edentulous Without teeth, lacking teeth.

edge-to-edge occlusion, edge-to-edge bite (Obj.) 1. An occlusion in which the anterior teeth of both jaws meet along their cutting edges when the teeth are in centric occlusion. 2. An occlusion characterized by incisal edge contact between the upper and lower teeth in centric occlusion.

end-to-end-bite (Obj.) (See *edge-to-edge occlusion*)

end-to-end occlusion (See *edge-to-edge occlusion*)

equilibration 1. Achieving of equilibrium of pressure. 2. To be in balance, as in balanced occlusion.

occlusal e. The modification of occlusal form by grinding with the intent of equalizing occlusal stress or of producing simultaneous occlusal contacts or of harmonizing cuspal relations.

equilibrator An instrument or device used in achieving or maintaining a state of equilibrium.

equilization of pressure The act of equalizing or evenly distributing pressure.

esthetics 1. The branch of philosophy dealing with beauty or the beautiful. 2. Of or pertaining to the beautiful as distinguished from the merely pleasing. 3. Referring to a pro-

duct (denture) which has a definite appreciative quality in terms of its material organization of form and color.

etiologic factors The elements or influences that can be assigned as the cause or reason for a disease or lesion.

examination Scrutiny or investigation for the purpose of making a diagnosis.

extension outline (for impression) 1. The outline of the area of the entire basal seat of a denture. 2. The outline on the surface of a cast or mucous membrane which includes the entire area to be covered by a denture.

F

face-bow 1. A caliper-like device which is used to record the relationship of the maxillae to the temporomandibular joint. 2. A caliper-like device which is used to record the relationship of the jaws to the temporomandibular joint and to orient the casts in this same relationship to the opening axis of the articulator.

hinge-bow, adjustable axis f.-b., kinematic f.-b. (Obj.) 1. A face-bow, the caliper ends of which have sufficient range of adjustment to permit the location of the axis of rotation of the mandible. 2. A face-bow with condyle rods adjustable in three dimensions to permit the location of the exact center of rotation of the mandible. It is attached to the mandibular teeth or record base.

face form 1. The outline form of the face from an anterior view. 2. The frontal outline form of the face.

facial profile 1. The outline form of the face from a lateral view. 2. The sagittal outline form of the face.

festoon Carvings in the base material of a denture which simulate the contours of the natural tissues which are being replaced by the denture.

final flask closure The last closure of a flask before processing, after trial packing the mold with a denture base material.

finish (of a denture) The final perfection of the form of the polished surfaces of a denture.

fit 1. The intimate contact of a denture base to the supporting tissue. 2. The adaptation of any dental restoration. (Viz. adaptation of an inlay to the cavity preparation with tooth or adaptation of a denture to its basal seat.)

fixed bridge (Obj.), **fixed partial denture** (See *partial denture*)

flabby tissue (See *tissue*)

flange That part of the denture base which extends from the cervical ends of the teeth to the border of the denture.

buccal f. The portion of the flange of a denture which occupies the buccal vestibule of the mouth.

f. contour The design of the flange of a denture.

denture f. 1. The essentially vertical extension from the body of the denture into one of the vestibules of the oral cavity. Also on the lower denture, the essentially vertical extension along the lingual side of the alveololingual sulcus. 2. The buccal and labial vertical extension of upper or lower denture base, and the lingual vertical extension of the lower one. The buccal and labial denture flanges have two surfaces: the buccal or labial surface and the basal seat surface. The lower lingual flange also has two surfaces: the basal seat surface and the lingual surface.

flask A sectional metal case in which a sectional mold is made of artificial stone or plaster of Paris for the purpose of compressing and processing dentures or other resinous restorations.

refractory f., casting f., casting ring A metal tube in which a refractory mold is made for casting metal dental appliances.

flask closure The procedure of bringing the two halves or parts of a flask together.

trial f.c. Preliminary closures made for the purposes of eliminating excess denture base material, and to make sure that the mold is completely filled.

flasking 1. The act of investing in a flask. 2. The process of investing the cast and a wax denture in a flask preparatory to molding the denture base material into the form of the denture.

foil 1. An exceedingly thin sheet of metal. 2. A thin pliable metal used as a separating material between the cast or flasking investment, and the denture base material.

forces of mastication The motive force created by the dynamic action of the muscles during the physiologic act of mastication.

framework The skeletal portion of an appliance (usually metal) around which and to which are attached the remaining portions of the appliance to produce the finished unit (partial denture).

Frankfort plane A plane passing through the lowest point in the margin of the orbit (the orbitale) and the highest point in the margin of the auditory meatus (the tragion).

free gingival margin The edge or summit of the free gingival tissue; free gum margin.

free mandibular movements 1. Any mandibular movements without tooth interference. 2. Any uninhibited movements of the mandible.

free-way space (See *interocclusal distance*)

fulcrum line An imaginary line drawn through the load areas of teeth with direct retainers around which line the denture tends to rotate under masticatory stress.

full denture (Obj.), **complete denture** (See *denture*)

full denture prosthetics (Obj.), **complete denture prosthetics** (See *prosthetics*)

functional chew-in record A record of the movements of the mandible made upon the occluding surface of the opposing occlusion rim by teeth or scribing studs and produced by simulated chewing movements.

functional mandibular movements 1. All normal movements of the mandible during speech, mastication, yawning, swallowing, and other associated movements. 2. Those movements used in function, usually chewing.

G

generated occlusal path (See *occlusal path, functional chew-in record*)

geriatrics That department of medicine or dentistry which treats all problems peculiar to old age and the aging, including the clinical problems of senescence and senility.

gerodontics, gerodontology 1. The study of the dentition in the aged or aging. 2. The branch of dentistry which deals with the dental condition of older people.

gingiva 1. That part of the gum tissue and mucous membrane which immediately surrounds a tooth and is continuous with its pericemental ligament. 2. A term to designate that part of the oral mucosa which covers and is firmly attached to the alveolar process. 3. The gum; the fibrous tissue, covered by mucous membrane which covers the alveolar processes of the upper and lower jaws and surrounds the necks of the teeth. (A.D.A.) (Dor.)

gingival retraction The displacement of the marginal gingivae away from a tooth.

gnathion The lowest point on the median line of the mandible.

gnathodynamometer 1. An instrument for measuring the force exerted in closing the jaws. (Dor.) 2. An instrument used for measuring biting pressure.

bimeter g. A gnathodynamometer equipped with a central-bearing point of adjustable height.

grinding-in A term used to denote the act of correcting occlusal disharmonies by grinding the natural or artificial teeth.

guide plane 1. The plane developed in the occlusal surfaces of the occlusion rims (viz., to position the mandible in centric relation). 2. A plane which guides movement.

gum contour Form of supporting structures of the teeth or of the flanges of dentures around the teeth.

gums (See *gingiva*) The fibrous and mucosa covering of the alveolar process or alveolar ridges.

H

hamular notch (See *pterygomaxillary notch*)

head of the condyle (Obj.) (See *condyle*)

heel (Obj.) (See *distal end*)

height of contour 1. A line encircling a tooth designating its greatest circumference. 2. The line encircling a tooth in a more or less horizontal plane and passing through the surface points of greatest radius.

high lip line 1. The greatest height to which the upper lip is raised during the act of smiling broadly or in excessive voluntary retraction of the upper lip. 2. The highest position of the upper lip in normal function.

hinge axis (See *axis*)

hinge-bow (See *face-bow*)

hinge joint Ginglymus; a joint which allows motion around an axis.

hinge movement An opening or closing movement of the mandible on the hinge axis.

hinge position 1. The position of the condyles in the temporomandibular joint at which a hinge movement of the mandible is possible. 2. The maxillomandibular relation from which a consciously stimulated true hinge movement can be executed.

terminal h.p. The mandibular position existing when the condyles are in such positions in the temporomandibular joints that an opening by hinge movement is possible beyond the amplitude of rest position. The position of the condyles is the most retruded of which they are capable. The movement from this position, which is a conditioned movement, is always less than median full mouth opening.

horizontal overlap, overjet, overjut The projection of the upper anterior and/or posterior teeth beyond their antagonists in a horizontal direction.

hydrocolloid The materials listed as colloid sols with water which are used in dentistry as elastic impression materials. Hydrocolloid can be reversible or irreversible.

irreversible h. alginate A hydrocolloid whose physical condition is changed by a chemical action which is not reversible.

reversible h. A hydrocolloid whose physical condition is changed by temperature. The material is made fluid by heat and becomes an elastic solid upon cooling.

hygroscopic expansion Expansion due to the absorption of moisture.

hyperplasia The abnormal multiplication or increase in the number of normal cells in normal arrangement in a tissue. (Dor.)

hyperplastic tissue (See *tissue*)

hypertrophy The morbid enlargement or overgrowth of an organ or part due to an increase in size of its constituent cells. (Dor.)

hypoplasia Defective or incomplete development. (Dor.)

I

-ics Indicative of a science, practice, or treatment. Trend is from *-ia* to *-ics* in dentistry. *Orthodontia* became *orthodontics* about 1937. (Gr.) Adjective ending *-ikos,* in ancient Greek times used without the following noun to indicate a practice. Example: *ethics.* Ending *-ics,* unlike *-ia,* can indicate only a practice, not a condition. To be preferred to *-ia.* (A.D.A.)

immediate denture, immediate insertion denture, immediate replacement denture (Obj.) (See *denture*)

implant A graft, or insert set firmly or deeply into or onto the alveolar process prepared for its insertion.

implant denture 1. An implant of a framework conformed and fastened to a portion of the bony structure of the maxillae or mandible with exposed metallic abutments protruding through the soft tissues covering the residual ridges, for the support of a dental prosthesis.

2. A denture which is made to rest upon metal implant framework abutments.

i.d. substructure The metal framework of an implant denture which is embedded beneath the soft tissues in contact with the bone.

i.d. superstructure The dentures which are retained and stabilized by the implant denture substructure.

impression 1. An imprint or negative likeness. 2. The negative form of the teeth and/or other tissues of the oral cavity, made in a plastic material which becomes relatively hard or set while in contact with these tissues. An impression is made in order to reproduce a positive form or cast of the recorded tissues. (Impressions are classified according to the materials of which they are made, alginate i., hydrocolloid i., modeling plastic i., plaster i., wax i.)

cleft palate i. An impression of a cleft palate.

complete denture i. 1. A negative registration of the entire denture-bearing, stabilizing, and border seal areas present in the edentulous mouth. 2. An impression of an edentulous arch made for the purpose of constructing a complete denture.

final i. An impression which is used for making the master cast.

hydrocolloid i. Any impression made in a hydrocolloid material.

mandibular i., lower i. An impression of the mandibular jaw or dental structures.

maxillary i., upper i. An impression of the maxillary jaw or dental structures.

partial denture i. 1. A negative copy of the partially edentulous dental arch or area made for the purpose of constructing a partial denture. 2. An impression of a part or all of a partially edentulous arch made for the purpose of designing or constructing a partial denture.

preliminary i. An impression made for the purpose of diagnosis or the construction of a tray.

sectional i. An impression that is made in sections.

impression area That surface which is recorded in an impression.

impression material Any substance or combination of substances used for obtaining a negative reproduction or impression.

impression technique A method and manner employed in making a negative likeness.

impression tray 1. A receptacle into which a suitable material is placed to make an impression. 2. A device which is used to carry, confine, and control an impression material for making an impression.

incisal guidance The influence on mandibular movements by the contacting surfaces of the mandibular and maxillary anterior teeth.

incisal guide That part of an articulator which maintains the incisal guide angle.

incisal guide angle The angle formed with the horizontal plane by drawing a line in the sagittal plane between incisal edges of the maxillary and mandibular central incisors when the teeth are in centric occlusion.

incisive papilla (See *papilla*)

index 1. A core or mold used to indicate the relative position of a tooth or teeth to one another and/or to a cast. 2. A guide, usually made of plaster, used to reposition teeth or casts or parts in order to reproduce their original position.

indirect retainer That part of a removable partial denture which assists the direct retainers in preventing free-end denture base displacement by functioning indirectly on the opposite side of the fulcrum line.

infrabulge (retention area of a tooth) That portion of the crown of a tooth gingival to the clasp guide or survey line.

initial contact 1. The first meeting of opposing teeth upon elevation of the mandible toward the maxillae. 2. The initial occlusal contact of parts of opposing teeth when the jaw is closed.

injection molding The forcing of the material into a mold from a separate chamber under pressure.

insertion The intraoral placing of a dental prosthesis.

path of i. The direction in which a restoration is inserted upon and removed from the abutment teeth.

interalveolar space (Obj.) (See *interarch distance*)

interarch distance, interridge distance 1. The vertical distance between the maxillary and mandibular arches (alveolar or residual) under conditions of vertical dimension which must be specified. 2. The vertical distance between the mandibular and maxillary alveolar or residual ridges. This is an incomplete term and should be modified by some specific reference to vertical dimension or occlusion. 3. The distance between the arches of the dentulous or edentulous bony processes when the teeth or occlusion rims are in contact. (Substituted for the term bite when it is to designate the distance between the alveolar ridges when the teeth are in occlusion.)

large i.d. Increased distance between the maxillary and mandibular arches.

small i.d. Reduced distance between the maxillary and mandibular arches.

interceptive occlusal contact 1. An initial contact of teeth which stops or deviates the normal movement of the mandible. 2. A contact of a tooth, teeth, or surfaces of opposing jaws which occurs before the remaining teeth and/or surfaces are in contact.

intercuspation The interdigitation of cusps of opposing teeth.

interdental The relationship between the proximal surfaces of the teeth of the same arch.

interdigitation (See *intercuspation*)

interfacial surface tension The molecular force which exists because of moisture content of the surface film of the mouth interposed between the denture base and tissues covered by the denture.

intermaxillary relation (Obj.) (See *maxillomandibular relation*)

intermediary movement All movements between the extremes of mandibular excursions.

internal attachment (See *attachment*)

interocclusal Between the occlusal surfaces of opposing teeth.

interocclusal distance, free-way space, interocclusal gap, interocclusal rest space, interocclusal clearance 1. The distance between the occluding surfaces of the maxillary and mandibular teeth when the mandible is in its physiologic rest position. 2. The distance between the rest vertical dimension and the occlusal vertical dimension of the face, as measured in the incisal region. 3. A measure of the distance between rest position and occluding position.

interocclusal record A record of the positional relation of the teeth or jaws to each other made on occlusal surfaces of occlusion rims or teeth in a plastic material which hardens, such as plaster of Paris, wax, zinc oxide and eugenol paste.

centric i.r. A record of the centric jaw position (relation).

eccentric i.r. A record of a jaw relation other than centric relation.

lateral i.r. A record of a lateral eccentric jaw position.

protrusive i.r. A record of a protruded eccentric jaw position.

interproximal space The space existing between adjacent teeth in a dental arch. It is divided into the embrasure occlusal to the contact point and the septal space gingival to the contact point.

interridge distance (See *interarch distance*)

intraoral Within the mouth. (Dor.)

invest To surround, envelop, or embed in an investment material.

investing The process of covering or enveloping wholly or in part an object such as a denture, tooth, wax form, crown, etc., with a refraction investment material before curing, soldering, or casting.

vacuum i. The investing of a pattern within a vacuum.

investment 1. Any material used in dentistry to invest an object. 2. The material used to enclose or surround a pattern of a dental restoration for casting or molding; or to maintain the relations of metal parts during soldering.

refractory i. An investment material which can withstand the high temperatures used in soldering or casting.

investment cast (Obj.), **refractory cast** (See *cast*)

irreversible hydrocolloid (See *hydrocolloid*)

J

jaw A common name for either the maxillae or the mandible.

jaw malposition Any abnormal position of the mandible.

jaw movement 1. Movements of the lower jaw. 2. All changes in position of which the mandible is capable.

jaw relation 1. Any relative position of the mandible to the maxillae. 2. Any of the various relations of the mandible to the maxillae.

unstrained j.r. 1. The relation of the mandible to the skull when a state of balanced tonus exists between all the muscles involved. 2. A relation of the mandible to the maxillae that exists only when all of the muscles attached to the mandible are in a state of tonic contraction. 3. A relation of the mandible to the maxillae which exists when no closing or retruding force is being exerted.

jaw repositioning The changing of any relative position of the mandible to the maxillae, usually by altering the occlusion of the natural or artificial teeth.

K

Kennedy bar (Obj.) (See *continuous bar retainer*)

kinematic face-bow (See *face-bow*)

L

labial 1. Of or pertaining to a lip. 2. Toward a lip.

lateral A position either right or left from the midsagittal plane.

1. incisor The second incisor.

lateral checkbite (Obj.) (See *checkbite*)

lateral condylar inclination The direction of the lateral condyle path.

lateral condyle path The path of the condyle in the glenoid fossa when a lateral mandibular movement is made.

lateral movement Movement of the mandible to the side.

line of occlusion The alignment of the occluding surfaces in reference to the dental arch.

lingual 1. Pertaining to the tongue. 2. Next to, or toward, the tongue. (D. & D.)

lingual plate A major partial denture connector formed as a lingual bar extended to cover the cingula of the lower anterior teeth.

lingual rest A metallic extension onto the lingual surface of a tooth to provide support or indirect retention for a removable partial denture.

low lip line 1. The lowest position of the lower lip during the act of smiling or voluntary retraction. 2. The lowest position of the upper lip at rest.

lower ridge slope 1. The slope of the mandibular residual ridge in the second and third molar region as seen from the buccal side. 2. That portion of the lower residual ridge, either lingual, labial, or buccal, between the crest of the ridge and the mucobuccal fold or flexion line of the peripheral tissues.

M

malocclusion 1. Any deviation from a physiologically acceptable contact of opposing dental arches. 2. Any deviation from a normal occlusion.

mandible The lower jawbone.

mandibular axis (Obj.), **hinge axis** (See *axis*)

mandibular glide The side-to-side, protrusive, and intermediate movement of the mandible occurring when the teeth or other occluding surfaces are in contact.

mandibular movement Any movement of the lower jaw.

mandibular protraction A type of facial anomaly in which the gnathion lies anterior to the orbital plane.

mandibular retraction A type of facial anomaly in which the gnathion lies posterior to the orbital plane.

masking An opaque covering to camouflage the metal parts of a prosthesis.

mastication The process of chewing food for swallowing and digestion.

components of m. The various jaw movements which are made during the act of mastication as determined by the neuromuscular system, the temporomandibular articulations, the teeth, and the food being chewed. The components of mastication may be separated (for purposes of analysis or description) into *opening components of mastication, closing components of mastication, left lateral components of mastication, right lateral components of mastication,* and *anteroposterior components of mastication.*

masticating cycles The patterns of mandibular movements formed during the chewing of food.

masticatory apparatus (Obj.) (See *stomatognathic system*)

masticatory force The capacity of the muscles of mastication to create a closing force.

masticatory movements 1. Chewing movements. 2. Mandibular movements used for chewing food.

masticatory system 1. The organs and structures primarily functioning in mastication. They are: jaws, teeth with their supporting structures, temporomandibular articulation, mandibular musculature, tongue, lips, cheeks, and oral mucosa. (A.D.A.)

maxillary protraction A type of facial anomaly in which the subnasion lies anterior to the orbital plane.

maxillofacial Pertaining to the jaws and the face. (Dor.)

maxillomandibular record, maxillomandibular registration 1. A record of the relation of the mandible to the maxillae. 2. The act of recording the relation of the mandible to the maxillae.

maxillomandibular relation Any one of the many relations of the mandible to the maxillae, such as centric maxillomandibular relation, eccentric maxillomandibular relation, etc.

mean foundation plane The mean of the inclination of the denture-supporting tissues. Since the tissues constituting the denture foundation are irregular in form and consistency, and since there is only one direction from which force may be applied if it is to comply with the law of statics requiring "force at right angle to support," the mean foundation plane forms a right angle with the most favorable direction of force.

mechanically balanced occlusion (See *balanced occlusion*)

median line 1. The cut of the midsagittal plane with the maxillary and mandibular dental arches. 2. The center line dividing the ventral body surface into right and left.

median relation (Obj.) (See *centric relation*)

median retruded relation (Obj.) (See *centric relation*)

mesial 1. Toward or situated in the middle, as the median line of the body or the center of the dental arch. 2. Situated in the middle; median, toward the middle line of the body or toward the center line of the dental arch. (Dor.)

metal base, metal saddle (Obj.) 1. The basal surface of a denture, constructed of metal, to which the teeth are attached. 2. The metal plate used for the support or attachment of artificial teeth.

milled-in paths 1. Contours carved by various mandibular movements into the occluding surface of an occlusion rim, by teeth or studs placed in the opposing occlusion rim. The paths or contours may be carved into wax, modeling plastic, or plaster of Paris. 2. Occlusal curves developed by masticatory or gliding movements of occlusion rims which are composed of materials including abrasives. (See also *functional chew-in record*)

milling-in The procedure of refining or perfecting the occlusion of teeth by the use of abrasives between their occluding surfaces while the dentures are rubbed together in the mouth or on the articulator. (See also *selective grinding*)

model (Obj.) See *cast*)

modeling composition, modeling plastic, modeling compound (Obj.) A thermoplastic material usually composed of gum damar and prepared chalk, used especially for making dental impressions.

mold 1. A form in which an object is cast or shaped. 2. The term used to specify the shape of an artificial tooth or teeth.

Monson curve (See also *compensating curve)* The curve of occlusion in which each cusp and incisal edge touches or conforms to a segment of the surface of a sphere eight inches in diameter.

mounting The laboratory procedure of attaching the maxillary and/or mandibular cast to an articulator.

mouth rehabilitation Restoration of the form and function of the masticatory apparatus to as nearly a normal condition as possible.

mucobuccal fold The line of flexure of the mucous membrane as it passes from the mandible or maxillae to the cheek.

mucostatic 1. The condition of mucosal tissues covering the jaws while at rest. 2. Arresting the secretion of mucus. (Dor.)

muscle trimming (Obj.), **border molding** (See *border*)

mushbite (Obj.) (See *maxillomandibular record*) A maxillomandibular record made by introducing a mass of soft wax into the patient's mouth and into which the patient is instructed to close to the desired degree. Not a generally accepted procedure.

mylohyoid region The region on the lingual surface of the mandible marked by the mylohyoid ridge and the attachment of the mylohyoid muscle.

N

nasion The point at which the nasofrontal suture is bisected by the midsagittal plane.

O

obturator 1. A dental prosthetic appliance used to close a congenital or acquired opening in the palate. 2. A dental prosthetic appliance used to close a cleft in the hard or soft palate or both, or to replace lost tissue necessary for the production of good speech and mastication.

occlude 1. To bring together; to shut. 2. To bring or close the mandibular teeth up into contact with the maxillary teeth.

occluder (Obj.) (See *articulator*) A name given to some articulators.

occluding frame (Obj.) (See *articulator*) A name given to a device for relating casts to each other for the purpose of arranging teeth.

occluding relation The jaw relation at which the opposing teeth occlude.

occlusal 1. Pertaining to the contacting surfaces of opposing occlusal units (teeth or occlusion rims). 2. Pertaining to the occluding surfaces of the posterior teeth.

occlusal analysis A study of the relations of the occlusal surfaces of opposing teeth.

occlusal balance 1. A condition in which equilibrium of the opposing occluding dental arches exists. 2. A condition in which there are simultaneous contacts on both sides of the opposing dental arches.

occlusal correction 1. The correction of malocclusion, by whatever means is employed. 2. The elimination of disharmony of occlusal contacts.

occlusal disharmony 1. Contacts of opposing occlusal surfaces of teeth which are not in harmony with other tooth contacts and with the anatomic and physiologic control of the mandible. 2. Occlusions which do not coincide with their respective jaw relations. (Centric occlusion should coincide with centric jaw relation, etc.)

occlusal force The resultant of muscular force applied on opposing teeth.

occlusal form The form of the occlusal surface of a tooth or of a row of teeth.

occlusal harmony Occlusions which are in harmony with similar jaw relations. Centric occlusion in harmony with centric jaw relation, etc.

functional o.h. Such occlusal relationship of opposing teeth in all functional ranges and movements as will provide the greatest masticatory efficiency without causing undue strain or trauma upon the supporting tissues.

occlusal path 1. A gliding occlusal contact. 2. The path of movement of an occlusal surface.

generated o.p. A registration of the paths of movement of the occlusal surfaces of mandibular teeth on a plastic or abrasive surface attached to the maxillary arch.

occlusal pattern The form or design of the occluding surfaces of a tooth or teeth. These forms may be based upon natural or modified anatomic or nonanatomic concepts of teeth.

occlusal pivot An elevation on the occlusal surface about which the mandible may rotate.

occlusal plane, plane of occlusion An imaginary surface which is related anatomically to the cranium and which theoretically touches the incisal edges of the incisors and the tips of the occluding surfaces of the posterior teeth. It is not a plane in the true sense of the word but represents the mean of the curvature of the surface. (See *curve of occlusion*)

occlusal position The relationship of the mandible and maxillae when the jaw is closed and the teeth are in contact. This position may or may not coincide with centric occlusion.

occlusal pressure Any force exerted upon the occlusal surfaces of teeth.

occlusal rest arm A minor connector used to attach an occlusal rest to a major part of a removable partial denture.

occlusal rim (Obj.) (See *occlusion rim*)

occlusal stop (Obj.), **occlusal rest** (See *rest*)

occlusal strength (Obj.) (See *masticatory force*)

occlusal surface A surface of a posterior tooth or occlusion rim which is intended to make contact with an opposing occlusal surface.

occlusal wear Attritional loss of substance on opposing occlusal units or surfaces. (See *abrasion*)

occlusion 1. Any contact of the lower with the upper occlusal surface. 2. The contacting of opposing occlusal surfaces when the jaws or the articulator are closed. 3. The relationship between the occlusal surfaces of the maxillary and mandibular teeth when they are in contact. 4. An anatomicophysiologic complex present when the opposing teeth are in contact. It consists of the positional relations, the stresses, strains, and resistance of structure (teeth, supporting structures, temporomandibular joints, and muscles). (See *components of occlusion*)

balanced o. The simultaneous contacting of the upper and lower teeth on the right and left and in the anterior and posterior occlusal areas. This occlusion is developed to prevent a tipping or rotating of the denture bases in relation to the supporting structures. It is thought of primarily in the mouth, but it is arranged and may be observed on articulators.

centric o. The relation of opposing occlusal surfaces which provides the maximum planned contact and/or intercuspation.

eccentric o. Any occlusion other than centric occlusion.

functional o. 1. Occlusion which occurs during function. 2. Functional occlusion directs attention specifically to performance, differentiated from structure and appearance. It should be used with modifying terms to indicate the degree of function that occlusion achieves. (A.D.A.) 3. Any tooth contacts made within the functional range of the opposing tooth surfaces.

gliding o. Used in the sense of designating contacts of teeth in motion; a substitute for the term articulation.

physiologic o. Occlusion in harmony with functions of the masticatory system.

protrusive o. An occlusion of the teeth when the mandible is protruded forward from centric position.

traumatic o. 1. Malocclusion which results in overstrain and injury to teeth, periodontal tissues, or to the tissue covering the residual ridge. 2. An occlusion of teeth which is so formed that it produces injury to the supporting tissues.

traumatogenic o. 1. A malocclusion capable of producing injury to the teeth or associated tissues. 2. An occlusion which is capable of producing injury to the teeth, periodontal membrane, or residual ridge.

occlusion rim, record rim 1. Occluding surfaces built on temporary or permanent denture bases for the purpose of making maxillomandibular relation records and for arranging

teeth. 2. The rim attached to the baseplate for the purpose of making maxillomandibular relation records.

open bite (Obj.), **large interarch distance** (See *interarch distance*)

opening movement Movement executed during jaw separation.

organ of mastication (Obj.) (See *stomatognathic system*)

overbite (Obj.) (See *vertical overlap*)

overclosure (See *reduced interarch distance*)

overjet, overjut (See *horizontal overlap*)

P

packing The act of filling a mold.

denture p. Filling and compressing a denture base material into a mold in a flask.

palatal seal (Obj.) (See *posterior palatal seal*)

papilla Any small, nipple-shaped elevation. (Dor.)

incisive p. The elevation of soft tissue covering the foramen of the incisive or nasopalatine canal.

parallel attachment (See *attachment*)

parallelometer 1. An instrument for measuring relative parallelism. 2. An apparatus used for making one part of an object parallel with some other part or object, or for paralleling attachments and abutments for fixed partial dentures or precision attachments for removable partial dentures.

partial denture 1. A prosthetic appliance which restores one or more, but less than all, of the natural teeth and/or associated parts, and which is supported by the teeth and/or the mucosa; it may be removable or fixed. 2. A dental prosthesis restoring a partial loss of the natural teeth and their associated parts.

distal extension p.d. A removable partial denture that is retained by natural teeth at one end of the denture base segments only, and in which a portion of the functional load is carried by the residual ridge.

fixed p.d. A restoration of one or more missing teeth which cannot be readily removed by the patient or dentist; it is permanently attached to natural teeth or roots which furnish the primary support to the appliance.

removable p.d. 1. An appliance which artificially supplies teeth and associated structures in a partially edentulous jaw, and which can be removed from the mouth and replaced at will. 2. An appliance which depends in part upon the mucosa for its support and which can be readily removed by the patient.

unilateral p.d. A dental prosthesis restoring lost or missing teeth only on one side of the arch.

partial denture construction The science and technique of designing and constructing partial dentures.

partial denture retention The means by which a removable partial denture is retained in position.

Passavant's pad, bar, ridge 1. The bulging "cross roll" of the posterior pharyngeal wall produced by the upper portion of the superior pharyngeal constrictor during the act of swallowing or vocal effort. 2. A ridge of erectile tissue on the posterior wall of the pharynx.

passivity The static condition assumed by a direct retainer after being seated upon an abutment tooth.

path of insertion (See *insertion*)

pathogenic occlusion An occlusal relationship which produces pathologic changes.

pathology The branch of medical science which deals with disease in all its relations, especially with its nature and the functional and material changes caused by it.

pathosis A disease entity.

pattern A form which is used to make a mold, as for an inlay or partial denture framework.

pear-shaped area (Obj.) (See *retromolar pad*)

peripheral seal (Obj.), **border seal** (See *border*)

periphery (Obj.), **denture border** (See *denture*)

phonetic values The character of quality of vocal sounds.

phonetics The science of sounds used in speech.

physiologic rest position 1. The mandibular position assumed when the head is in an upright position and the involved muscles, particularly the elevator and depressor groups, are in equilibrium in tonic contraction, and the condyles are in a neutral, unstrained position. 2. The position assumed by the mandible when the attached muscles are in a state of tonic equilibrium. The position is usually noted when the head is held upright.

physiologically balanced occlusion (See *balanced occlusion*)

pickle The process of cleansing of metallic surfaces of the product of oxidation and other impurities by immersion in acid.

pier (Obj.) (See *abutment*)

plane of occlusion (See *occlusal plane*)

planes of reference Planes which act as a guide to the location of other planes.

plaster A colloquial term applied to dental plaster of Paris.

plaster of Paris 1. Calcined calcium sulfate in the form of a fine white powder. About one-half of the water of crystallization has been driven off, and when water is added it solidifies to a porous mass that is used extensively in dentistry and in surgery. (Dor.) 2. Calcined calcium sulfate, which when mixed with water, forms a hard compound. 3. The hemihydrate of calcium sulfate, which, when mixed with water, forms a paste which subsequently sets.

plastic base A denture or record base made of a plastic material.

Pleasure curve (Obj. (See *reverse curve*)

polishing 1. To make smooth and glossy, usually by friction; to give luster to. 2. The act or process of making a denture or casting smooth and glossy.

polymerization The forming of a compound from several single molecules of the same substance, the molecular weight of the new compound being a multiple equal to the number of single molecules which have been combined. (Gould)

pontic The suspended member of a fixed partial denture. It replaces the lost natural tooth, restores its functions, and usually occupies the space previously occupied by the natural crown.

post dam (Obj.) (See *posterior palatal seal*)

post dam area (Obj.) (See *posterior palatal seal area*)

posterior palatal seal The seal at the posterior border of a denture.

posterior palatal seal area The soft tissues along the function of the hard and soft palates on which pressure within the physiologic limits of the tissues can be applied by a denture to aid in the retention of the denture.

postpalatal seal (Obj.) (See *posterior palatal seal*)

postpalatal seal area (Obj.) (See *posterior palatal seal area*)

pre-extraction cast (Obj.), **study cast** (See *cast*)

pre-extraction records (See *pre-operative records*)

premature contact (Obj.) (See *deflective occlusal contact,* and *interceptive occlusal contact*)

prematurity (Obj.) (See *deflective occlusal contact,* and *interceptive occlusal contact*)

pre-operative cast (Obj.), **study cast** (See *cast*)

pre-operative records, pre-extraction records Any record or records made for the purpose of study or treatment planning.

pressure area An area of excessive displacement of tissue.

primary impression (Obj.), **preliminary impression** (See *impression*)

process *n.* 1. (anatomy) A marked prominence or projection of a bone. 2. (dental) A series of operations which convert the wax pattern of the denture base into a solid denture base of another material. *v. t.* To subject a material such as a denture base material to a series of operations to convert the soft mass of plastic resin into a solid denture base. (Obj.) (See *cure*)

p. a denture 1. The series of steps or a prescribed method for producing a finished denture after the flasking procedures are completed. 2. The series of steps involved in changing the denture base material from a plastic moldable mass to the solid shape of a denture. (Obj.) (See *cure*)

profile An outline or contour, especially one representing a side view of a human head.

profile record A registration or record of the profile of a patient.

prognosis A forecast as to the probable result of an attack of disease; the prospect as to recovery from a disease afforded by the nature and symptoms of the case. In denture service, an opinion of the prospects for success of a restoration.

denture p. An opinion or judgment of the prospects for success in the construction and usefulness of dentures given in advance of treatment.

prosthesis The replacement of an absent part of the human body by an artificial one.

cleft palate p. An appliance to correct congenital acquired defects in the palate and related structures if they are involved.

complete denture p. (See *denture*), **partial denture p.** 1. An appliance which artificially restores missing parts but not all of the dental arch and the contiguous tissues. A fixed or removable partial denture. 2. The art and science of constructing partial denture restorations.

dental p. An artificial replacement of one or more teeth and/or associated structures.

postsurgical p. 1. An artificial replacement of a missing part or parts following surgery. 2. An artificial replacement of facial or oral structures made necessary by surgical treatment.

surgical p. An artificial appliance prepared to assist in surgical procedures.

prosthetic dentistry (See *prosthodontics*)

prosthetic restoration (Obj.) (See *prosthesis*)

prosthetic speech aid (See *speech aid*)

prosthetics The art and science of supplying missing parts of the human body.

complete denture p. 1. The restoration of the natural teeth in the arch and their associated parts by artificial replacements. 2. The art and science of the restoration of an edentulous mouth.

prosthetist An individual involved in the construction of an artificial replacement for any part of the human body.

prosthodontia (Obj.) (See *prosthodontics*)

prosthodontics, prosthetic dentistry 1. That branch of dental art and science pertaining to the restoration and maintenance of oral function by the replacement of missing teeth and structures by artificial devices. 2. The science and art of providing suitable substitutes for the coronal portions of teeth, or for one or more lost or missing natural teeth and their associated parts, in order that impaired function, appearance, comfort, and health of the patient may be restored. (A.D.A.)

prosthodontist A dentist engaged in the practice of prosthodontics.

protrusion A position of the mandible forward or lateral to centric position.

forward p. A forward position of the mandible.

lateral p. A position of the mandible to the right or left of centric position.

protrusive checkbite (Obj.) (See *protrusive record, checkbite*)

protrusive record A registration of a forward position of the mandible with reference to the maxillae.

protrusive relation The relation of the mandible to the maxillae when the lower jaw is thrust forward.

psychosomatic Pertaining to the mind-body relationship; having bodily symptoms of a psychic, emotional, or mental origin. (Dor.)

p. dentistry Dentistry which concerns itself with the mind-body relationship.

pterygomaxillary notch, hamular notch The notch or fissure formed at the junction of the maxilla and the hamular or pterygoid process of the sphenoid bone.

Q

quick cure resin (Obj.), **autopolymer resin** (See *resin*)

R

radiogram (Obj.), **radiograph** (Obj.) (See *roentgenogram*)

rebase A process of refitting a denture by the replacement of the denture base material without changing the occlusal relations of the teeth.

reciprocal The manner in which one part of an appliance is made to counter the effect created by another part.

reciprocal arm A clasp arm or other extension used on a removable partial denture to oppose the action of some other part or parts of the appliance.

record base (See *baseplate*)

record rim (See *occlusion rim*)

reduced interarch distance, overclosure An occluding vertical dimension which results in an excessive interocclusal distance when the mandible is in rest position and in a reduced interridge distance when the teeth are in contact.

refractory cast (See *cast*)

refractory investment (See *investment*)

registration The record of desired jaw relations in order to transfer these relations to an articulator.

relief The reduction or elimination of pressures from a specific area under a denture base.

r. area The portion of the surface of the mouth upon which pressures are reduced or eliminated.

r. chamber A recess in the impression surface of a denture to reduce or eliminate pressures from that specific area of the mouth.

reline To resurface the tissue side of a denture with new base material to make it fit more accurately.

removable bridge (Obj.), **removable partial denture** (See *partial denture*)

residual ridge (See *ridge*)

resin A broad term used to indicate organic substances usually translucent or transparent, soluble in ether, etc., but not in water. They are named according to their chemical composition, physical structure, and means for activation or curing. Examples, acrylic r., autopolymer r., synthetic r., styrene r., vinyl r.

acrylic r. A general term applied to a resinous material of the various esters of acrylic acid. It is used as a denture base material and for trays and other dental restorations.

a.r. base A plastic denture base made of an acrylic resin.

a.r. denture A denture made of acrylic resin.

a.r. tooth A tooth made of acrylic resin.

a.r. tray A tray made of acrylic resin.

copolymer r. A synthetic resin which is the product of the concurrent and joint polymerization of two or more different monomers or polymers.

resorption 1. A loss of substance by physiologic or pathologic means. 2. The reduction of the volume and size of the alveolar portion of the mandible or maxillae.

rest An extension from an appliance that affords support to a restoration.

incisal r. 1. A rest placed on the incisal edge of a tooth. 2. A metallic extension at the incisal angle of an anterior tooth to supply tooth support for the removable partial denture and to maintain the clasp in its proper position on the tooth. 3. An indirect retainer, placed in the incisal edge of an anterior tooth.

occlusal r. A rest placed on the occlusal surface of a posterior tooth. A metallic extension on the occlusal surface of a tooth to provide support for a removable partial denture.

precision r. A rest consisting of interlocking parts.

rest area 1. The portion of the tooth selected and prepared to receive an occlusal or an incisal rest. 2. The portion of tooth structure or of a restoration in a tooth prepared

so it is spoon-shaped on posterior teeth and "V"-shaped or hook-shaped on some anterior teeth, into which seats the metallic occlusal or incisal rest of a partial denture.

rest occlusion (Obj.), **rest bite** (Obj.) (See *physiologic rest position*) These are contradictory terms which should not be used.

rest position (See *physiologic rest position*)

rest relation The relation of the mandible to the maxillae at which there exists in all of the muscles involved a state of balanced tonus. The rest relation of the mandible exists when all of the muscles involved are in a state of balanced tonus but the degree of jaw separation in rest relation is dependent on the sagittal inclination of the head. (See *physiologic rest position*)

restoration, prosthetic restoration, appliance Broad terms applied to any inlay, crown, bridge, partial, or complete denture which restores or replaces loss of tooth structure, teeth, or oral tissues, (A.D.A.)

retainer 1. Any form of attachment applied directly to an abutment tooth used for the fixation of the prosthetic restoration. 2. That part of a fixed or removable partial denture which unites the abutment tooth with the suspended portion of the restoration.

retention 1. The fixation of a dental prosthesis in position. 2. The means by which a removable partial denture is maintained in a functional position.

direct r. Retention obtained in a removable partial denture by the use of attachments or clasps which resist their removal from the abutment teeth.

indirect r. Retention obtained in a removable partial denture through the use of indirect retainers. (See *indirect retainer*)

retention arm An extension which is part of a removable partial denture and is utilized to aid in the fixation of the appliance; a part of a clasp.

retention of denture The resistance of a denture to dislodgment.

retromolar pad A mass of tissue, frequently pear-shaped, which is located at the distal termination of the mandibular residual ridge.

retrusion 1. Retraction of the mandible from any given point. 2. The backward movement of the mandible.

reverse curve A curve in the alignment of the occlusal surfaces of teeth which is convex upward in the opposite direction from a compensating curve. It may exist in the frontal or sagittal plane or both. (See *compensating curve*)

reversible hydrocolloid (See *hydrocolloid*)

ridge The ridge is the remainder of the alveolar process after the teeth are removed.

alveolar r. The bony ridge (alveolar process) of the maxillae or mandible which contains the alveoli (sockets of the teeth).

center of r. The buccolingual midline of the residual ridge.

crest of r. The highest continuous surface of the ridge, but not necessarily the center of the ridge. The top of a residual or alveolar ridge.

residual r. The portion of the alveolar ridge which remains after the alveoli have disappeared from the alveolar process after the teeth have been removed.

ridge relation The positional relation of the mandibular ridge to the maxillary ridge.

Roach clasp (Obj.), **bar clasp** (See *clasp*)

roentgenogram, roentgenograph The shadow image of radiopaque anatomic structures recorded upon film sensitized to roentgen rays.

roentgenographic interpretation An opinion formed from the study of a roentgenograph.

rotation center A point or line around which all other points in a body move.

rugae The irregular ridges in the mucous membrane covering the anterior part of the hard palate.

rugae area, rugae zone (Obj.) The portion of the mouth in which rugae are found.

S

saddle (Obj.), **denture base** (See *denture*)

scribe To write, trace, or mark by making a line or lines with a pointed instrument.

segment Any of the parts into which a body naturally separates or is divided, either actually or by an imaginary line.

selective grinding 1. The modification of the occlusal forms of teeth by grinding according to a plan. 2. The modification of the occlusal forms of teeth by grinding at selected places marked by spots made by articulating paper.

separating medium 1. Any coating used upon a surface which serves to prevent another surface from adhering to the first. 2. A material usually coated on impressions to facilitate removal of the cast.

setting expansion The dimensional increase which occurs concurrently with the hardening of various materials, such as plaster of Paris.

set-up The arrangement of teeth on a trial denture base.

shade selection, tooth color selection The determination of the color (hue, brilliance, saturation) of an artificial tooth or set of teeth for a given patient.

shellac bases Certain resinous materials adapted to maxillary or mandibular casts to form baseplates.

single denture construction The making of one upper or lower denture as distinguished from a set of complete dentures.

slotted attachment (Obj.) (See *attachment*)

snap impression (Obj.), **preliminary impression** (See *impression*)

solder 1. A fusible alloy of metals used to unite the edges or surfaces of two pieces of metal. (Dor.) 2. The act of uniting two pieces of metal by the proper alloy of metals.

spatulate To manipulate or mix with a spatula.

spatulation The manipulation of material with a spatula in order to mix it into a homogenous mass.

speech aid Treatment to improve speech.

prosthetic s.a. An appliance used to close a cleft in the hard or soft palate or both; or to replace lost tissue necessary for the production of good speech.

surgical s.a. Modification of the oral tissues by surgical means which improves speech.

spherical form of occlusion An arrangement of teeth which places their occlusal surfaces on the surface of an imaginary sphere (usually eight inches in diameter) with its center above the level of the teeth.

splint A rigid or flexible appliance for the fixation of displaced or movable parts.

splinting (in abutments) The joining of two or more teeth into a rigid unit by means of fixed restorations.

split cast method 1. A procedure for placing indexed casts on an articulator to facilitate their removal and replacement on the instrument. 2. The procedure of checking the ability of an articulator to receive or adjust to a maxillomandibular relation record.

split cast mounting 1. A cast with key grooves on its base, mounted on an articulator for the purpose of easy removal and accurate replacement. Split remounting metal plates may be used instead of grooves in casts. 2. A means for testing the accuracy of articulator adjustment.

sprue Wax or metal used to form the aperture or apertures for molten metal to flow into a mold to make a casting; also the metal which later fills the sprue hole or holes.

sprue former The base to which the sprue is attached while the wax pattern is being invested in a refractory investment in a casting flask.

stability 1. The quality of a denture to be firm, steady, constant, and not subject to change of position when forces are applied. 2. The quality of a denture to resist displacement by functional stresses.

stabilization The seating of a fixed or removable denture so that it will not tilt or be displaced under pressure.

stabilized baseplate (See *baseplate*)

staining Modification of the color of the tooth or denture base.

static relations Relationship between two parts that are not in motion.

stomatognathic system The combination of all the structures involved in speech, and the receiving, masticating, and deglutition of food.

stomatology The study of the structures, functions, and diseases of the mouth.

stone die A positive likeness in artificial stone used in the fabrication of a restoration.

stress-bearing area 1. The portion of the mouth which provides support for a denture. 2. Surfaces of oral structures which resist forces, strains, or pressures brought upon them during function.

stress breaker A device which relieves the abutment teeth of all or part of the occlusal forces.

sublingual Pertaining to the region or structures located beneath the tongue.

sublingual crescent The crescent-shaped area on the floor of the mouth formed by the lingual wall of the mandible and the adjacent part of the floor of the mouth.

sublingual fold The crescent-shaped area on the floor of the mouth following the inner wall of the mandible and tapering toward the molar regions. It is formed by the sublingual gland and submaxillary duct.

subocclusal surface A portion of the occlusal surface of a tooth which is below the level of the occluding portion of the tooth.

suction chamber (Obj.), **relief chamber** (See *relief*)

suction cup (Obsolete) A thin rubber disc usually with a hole in its center which fits over a button which is larger in diameter than the hole. This causes the disc to assume a cup shape. When applied in the tissue surface of a denture the cup attaches itself to the mucous membrane by suction.

sulcus 1. A furrow, trench, or groove, as on the surface of the brain or in folds of mucous membrane. 2. A groove or depression on the surface of a tooth. 3. A groove in a portion of the oral cavity.

supporting area 1. The surface of the mouth available for support of a denture. 2. Those areas of the maxillary and mandibular edentulous ridges which are considered best suited to carry the forces of mastication when the dentures are in function.

suprabulge That portion of the crown of a tooth which converges toward the occlusal surface of the tooth.

surgical template (See *template*)

survey The procedure of locating and delineating the contour and position of the abutment teeth and associated structures before designing a removable partial denture.

survey line 1. The line indicating the height of contour of a tooth after the cast has been positioned according to the chosen path of insertion. 2. A line produced on a cast of a tooth by a surveyor scriber. It marks the greatest height of contour in relation to the chosen path of insertion of the restoration. 3. A line drawn on a tooth or teeth by means of a surveyor for the purpose of determining the positions of the various parts of a clasp or clasps.

swage To shape metal by hammering or adapting it onto a die.

swallowing threshold The critical moment of reflex action initiated by minimum stimulation, prior to the act of deglutition.

T

technique, technic (Obj.) 1. A detailed method or procdure used in the preparation and construction of a prosthetic appliance. 2. The skill used in the execution of a procedure.

teeth (pl. of tooth) Organs of mastication.

anatomic t. 1. Artificial teeth which more or less duplicate the anatomic forms of natural teeth. 2. Teeth which have notably pointed or rounded eminences on the masticating surfaces, and designed to occlude in the sulci of the antagonizing teeth or the opposite dental arch.

artificial t. Teeth fabricated for use as a substitute for the natural teeth.

cross-bite t. Posterior teeth designed to permit the locating of the modified buccal cusps of the upper members in the fossae of the lowers.

cuspless t. Teeth designed without cuspal prominences on the masticatory surfaces.

metal insert t. Prosthetic teeth containing metal cutting surfaces inserted into the occlusal surface.

nonanatomic t. 1. Teeth whose occlusal surfaces are not based on anatomic forms. 2. Artificial teeth so designed that the characteristics of natural occlusal surfaces are not copied from natural forms, but rather are given forms, which in the opinion of the designer seem more nearly to fulfill the requirements of mastication, tolerance, etc.

plastic t. Artificial teeth constructed of synthetic resins.

set of t. Usually refers to a full complement of maxillary and mandibular artificial teeth, as they are carded by the manufacturer.

tube t. An artificial tooth constructed with a vertical, cylindrical aperture extending from the center of the base up into the body of the tooth into which a pin may be placed or cast for the attachment of the tooth to a denture base.

zero degree t. Prosthetic teeth having no cusp angle in relation to the horizontal.

template A pattern or mold; a curved or flat plate utilized as an aid in setting teeth.

surgical t. A thin transparent resin base shaped to duplicate the form of the impression surface of an immediate denture, and used as a guide for shaping the alveolar process to fit an immediate denture.

temporary restoration, temporary appliance A fixed or removable restoration whose replacement with a more permanent appliance is planned within a short period of time.

temporomandibular articulation, temporomandibular joint (See *articulation*)

tension The state of being stretched, strained, or extended.

terminal hinge position (See *hinge position*)

thermal expansion Expansion caused by heat.

thermoplastic A material which can be made soft by the application of heat and which hardens upon cooling.

tinted denture base A denture base which simulates the coloring and shading of natural oral tissues.

tissue 1. The various cellular combinations which make up the body. 2. An aggregation of similarly specialized cells united in the performance of a particular function. (Dor.)

hyperplastic t., flabby t. Excessively movable tissue about the maxillae or mandible which usually results from ill-fitting dentures or malocclusion. It occurs frequently beneath an upper denture occluding against six or eight lower anterior teeth.

tissue-bearing area (Obj.) (See *denture foundation*)

tissue displaceability 1. The quality of oral tissues which permits them to be placed in other than their relaxed position. 2. The degree to which tissues permit displacement.

tissue displacement The change in the form or position of tissues as the result of pressure.

tissue molding (Obj.), **border molding** (See *border*)

tissue reaction The response of tissues to altered conditions.

tissue registration 1. The accurate registration of the shape of tissues under any condition by means of a suitable material. 2. An impression.

tissue trimming (Obj.), **border molding** (See *border*)

tooth arrangement 1. The placement of teeth on a denture with definite objectives in mind. 2. The setting of teeth on temporary bases.

anterior t.a. The arrangement of anterior teeth for esthetic or phonetic effects.

tooth-borne A term used to describe a restoration or part of a restoration which depends entirely upon the abutment teeth for support. (S.)

tooth-borne base The denture base restoring an edentulous area which has abutment teeth at each end for support. The tissue which it covers is not used for support.

tooth form A differentiation of the curves, lines, angles, and contours of various types of teeth.

anterior t.f. The outline form and other contours of an anterior tooth.

posterior t.f. The distinguishing contours of the occlusal surface of the various posterior teeth

tooth selection The selection of a tooth or teeth in shape, size, and color to harmonize with the individual characteristics of a patient.

torque A rotatory force applied to a denture base.

tracer 1. A mechanical device used to trace a pattern of mandibular movements. 2. A mechanical device with a marking point, attached to one jaw and a graph plate or tracing plate attached to the other jaw. It is used to record the direction and extent of movements of the mandible.

needle point t., stylus t., Gothic arch t., arrow point t., sea gull t. A device used in registering centric position and eccentric mandibular movements in the horizontal plane.

tracing A line or lines, scribed by a pointed instrument, representing a record of movements of the mandible.

extraoral t. A tracing made outside the oral cavity.

intraoral t. A tracing made within the oral cavity.

needle point t., stylus t., Gothic arch t., arrow point t., sea gull t. A tracing which resembles an arrowhead or a Gothic arch or a sea gull made by means of a device attached to the opposing arches. The shape of the tracing depends upon the relative location of the marking point and the tracing table. The apex of a properly made tracing is considered to indicate the most retruded unstrained relation of the mandible to the maxillae, centric relation.

translatory movement The motion of a body at any instant when all points within the body are moving at the same velocity and in the same direction.

trauma 1. A hurt; a wound; an injury; damage; impairment; external violence producing bodily injury or degeneration. (D. & D.) 2. An actual alteration of tissue produced by dental dysharmony.

traumatic Of, or pertaining to, or caused by, an injury. (Dor.)

traumatogenic Capable of producing a wound or injury.

treatment plan The sequence of procedures planned for the treatment of a patient.

trial denture, trial plate (Obj.) A setup of artificial teeth so fabricated that it may be placed in the patient's mouth to verify esthetics, for the making of records or any other operation deemed necessary before the final completion of the denture.

try-in A preliminary insertion of a complete denture wax-up or of a partial denture casting or of a finished restoration to determine the fit, esthetics, maxillomandibular relation, etc.

U

undercut 1. That portion of a tooth which lies between the survey line and the gingivae. 2. The contour of a cross section of a residual ridge or dental arch which would prevent the insertion of a denture. 3. The contour of flasking stone which interlocks in such a way as to prevent the separation of the parts.

unstrained jaw relation (See *jaw relation*)

V

vacuum mixing A method of mixing a material in a vacuum.

vertical dimension A vertical measurement of the face with which is correlated the distance between the upper and lower dentitions or the residual ridges.

v.d. of occlusion, occlusal v.d. 1. The vertical measurement of the face when the teeth are in occlusal contact. 2. The vertical separation of the mandibular residual or alveolar ridge from the maxillary residual or alveolar ridge and the resultant facial profile as established by occlusal contacts. 3. The vertical face length as established by the contacts of teeth or occlusion rims.

v.d. of rest position, rest v.d. 1. The vertical measurement between the two jaws that exists when the mandible is in physiologic rest position. 2. The vertical measurement of the face when all of the muscles attached to the mandible are in a state of tonic contraction only. (See *physiologic rest position*)

vertical dimension decrease Decreasing the vertical distance between the mandible and the maxillae by modifications of teeth, the positions of teeth or occlusion rims, or through alveolar or residual ridge resorption.

vertical dimension increase Increasing the vertical distance between the mandible and the maxillae by modifications of teeth, the positions of teeth, or occlusion rims.

vertical opening (Obj.) (See *vertical dimension*)

vertical overlap 1. The extension of the upper teeth over the lower teeth in a vertical direction when the opposing teeth are in contact in centric occlusion. 2. The distance teeth lap over their antagonists vertically. This term is used especially for the distance the upper incisal edges drop below the lower ones, but can be used also to describe the vertical relations of the opposing cusps.

vestibule (of the mouth) That portion of the oral cavity which lies between the teeth and gingivae, or the residual ridges, and the lips and cheeks.

buccal v. The space between the alveolar or residual ridge and the cheek.

labial v. The space between the alveolar or residual ridge and the lips.

vibrating line 1. The imaginary line across the posterior part of the palate marking the division of the movable and immovable tissues. 2. The imaginary line across the posterior part of the palate which marks the beginning of motion in the palate.

vulcanite 1. A combination of caoutchouc and sulfur, which hardens in the presence of suitable heat and pressure. 2. A chemical combination of caoutchouc and sulfur which has been subjected to the process of vulcanization.

vulcanize To produce flexible or hard rubber as desired, by subjecting caoutchouc, in the presence of sulfur, to heat and high steam pressure in a vulcanizer. (D. & D.)

W

warp Torsional change of shape or outline, such as that which may occur in swaging sheet metal, or in denture material, or in other materials when exposed for long periods to varying temperatures.

wax expansion A method of expanding the wax patterns to compensate for the shrinkage of gold during the casting process.

wax model denture (See *trial denture*)

wax pattern A wax form of a shape which, when invested and burned out, will produce a mold in which the casting is made.

waxing The contouring of a wax pattern or the wax base of a trial denture into the desired form.

waxing up 1. The contouring of a pattern in wax, generally applied to the shaping in wax of the contours of a trial denture. 2. The process of waxing and carving of the wax to the shape and contour desired.

working bite (Obj.) (See *working occlusion*)

working contacts Contacts of teeth made on the side of the occlusion toward which the mandible has been moved.

working occlusal surface The surface or surfaces of teeth upon which mastication can occur.

working occlusion The occlusal contacts of teeth on the side to which the mandible is moved.

working side The lateral segment of a denture or dentition toward which the mandible is moved.

X

x-ray (See *roentgenogram*)

x-ray picture (Obj.) (See *roentgenogram*)

5930